AR TARGET SHEET

The following document was too large to scan as one unit, therefore it has been broken down into sections.

DOCUMENT # DOE/EIS-0189D

EDMC # 0043485

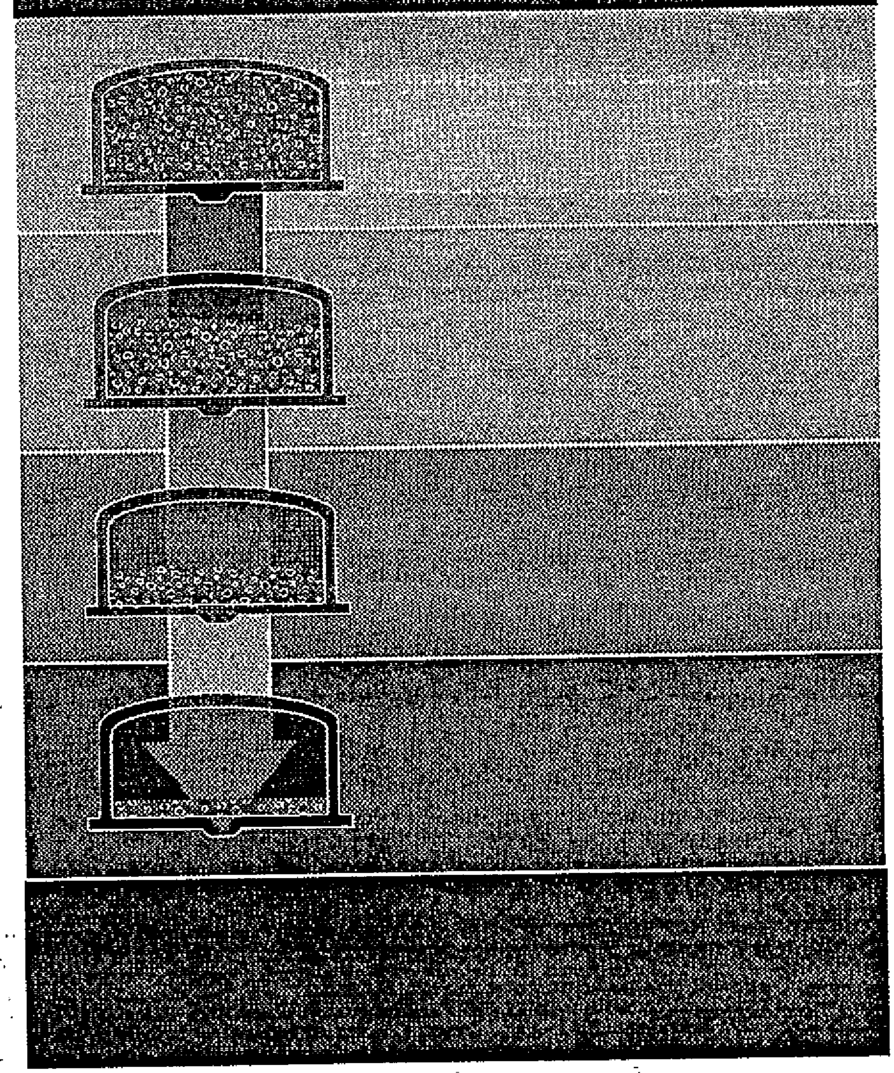
SECTION 1 **OF** 3

0043485
1 of 6

DOE/EIS-0189D

Draft Environmental Impact Statement for the Tank Waste Remediation System

Summary



Prepared by:

U.S. Department of Energy
and
Washington State Department of Ecology

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 1996

ATTACHMENT
VARIATION OF THE EX SITU/IN SITU COMBINATION ALTERNATIVE

This variation of the Ex Situ/In Situ Combination alternative and other potential variations of existing alternatives presented in the EIS are available for public comment and will be considered by DOE while preparing the Final EIS.

1.0 OVERVIEW

The variation of the Ex Situ/In Situ Combination alternative is similar to the Ex Situ/In Situ Combination alternative addressed in the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS). However, the selection criteria for the waste that would be treated ex situ would be modified, providing for ex situ treatment of the largest contributors to long-term risk (Tc-99, C-14, I-129, and U-238) while limiting the volume of waste to be processed. Reducing the volume of waste requiring ex situ processing would likely reduce the required capacity of the treatment facility, occupational risks, and costs. The modified selection criteria would result in approximately 23 tanks selected for ex situ treatment instead of 70 tanks, based on currently available characterization data. This variation has not been fully developed into an alternative so the information presented in the following text is based on approximations, providing the reader with a general idea of the potential impacts associated with implementing the alternative.

Waste selected for ex situ treatment would be retrieved and transferred to processing facilities for treatment. Two treatment facilities would be constructed for ex situ treatment and would include one combined separations and low-activity waste treatment facility and one high-level waste treatment facility. The waste volume to be retrieved for ex situ treatment would be approximately 26 percent of the total tank waste volume obtained from approximately 13 percent of the tanks. The actual number of tanks would be based on future characterization of the tanks.

Waste contained in tanks selected for in situ treatment would be treated using the same process as described for the In Situ Fill and Cap alternative. In situ treatment of double-shell tanks would include evaporating as much water as practicable from the waste in the 242-A Evaporator. Each tank, both single-shell and double-shell tanks, would then be filled with gravel to stabilize the tank and prevent a dome collapse. Waste tanks selected for ex situ treatment would have waste retrieved, separated, and immobilized. An earthen infiltration cover would be constructed over all tank farms and low-activity waste disposal vaults to reduce water infiltration and inhibit human intrusion.

The potential benefit of this alternative is that by selecting the appropriate tanks for ex situ treatment, up to 85 percent of the constituents that are the greatest contributors to long-term risk would be disposed of ex situ while retrieving approximately 26 percent of the waste.

2.0 PROCESS DESCRIPTION

The first step in waste processing would be to recover and transfer selected waste for treatment. Waste retrieval and transfer would use the same technologies and processes as described for the Ex Situ Intermediate Separations alternative. Waste retrieval would use sluicing and arm-based systems for the single-shell tanks and slurry pumping for the double-shell tanks.

The separations and immobilization technologies used would be similar to those processes described for the Ex Situ Intermediate Separations alternative with additional separation steps to remove selected constituents from the low-activity waste stream. The low-activity waste treatment facility would be designed to produce approximately 50 metric tons (mt)/day (55 tons/day) of immobilized waste. The immobilized low-activity waste would be placed into containers for onsite near-surface disposal.

The high-level waste treatment process would be designed to produce 5 mt/day (5.5 tons/day) of high-level waste glass. The immobilized high-level waste would be placed directly into standard sized canisters and packaged into Hanford Multi-Purpose Canisters for interim onsite storage and eventual transport to a geologic repository. In situ treatment would begin by concentrating the double-shell tank waste followed by gravel filling of the remaining single-shell and double-shell tanks. The construction of the earthen infiltration cover would occur during closure following stabilization of the tanks selected for retrieval and in situ treatment.

3.0 CONSTRUCTION

Two treatment facilities would be constructed for ex situ processing. One facility would be a separations and low-activity waste treatment facility and the other would be a high-level waste treatment facility. The two treatment facilities would be located in the 200 East Area within the area identified for the Ex Situ Intermediate Separations alternative. The following systems and facilities would be constructed for ex situ treatment:

- Waste retrieval and transfer systems;
- Treatment facilities (one separations/low-activity waste treatment facility and one high-level waste treatment facility);
- Interim storage pads for immobilized high-level waste in the 200 East Area; and
- A low-activity waste disposal facility to provide for retrievable disposal of the low-activity waste.

Construction activities for the in situ activities would include filling the tanks with gravel, which would require installing gravel handling equipment, modifying tank openings to accommodate gravel handling equipment, and constructing gravel stockpiles.

4.0 SCHEDULE AND COST

The schedule for this variation to the Ex Situ/In Situ Combination alternative would begin with construction as early as 1998 with operations taking place from 2002 to 2024. The last high-level waste would be transported offsite by 2029, closure activities would be completed by 2034, and monitoring and maintenance would continue until 2134.

The total cost for this variation to the Ex Situ/In Situ Combination alternative would be less than that of the Ex Situ/In Situ Combination alternative due to the fewer number of tanks retrieved, the smaller production of the ex situ processing facilities, and fewer canisters of HLW requiring disposal in a geologic repository.

5.0 ENVIRONMENTAL IMPACTS

When compared to the Ex Situ/In Situ Combination alternative, this variation may result in fewer potential latent cancer fatalities from routine exposures during remediation, lower occupational fatalities, and a lower probability of accidents during operations and transportation. It may also result in less disturbance of the shrub-steppe habitat, fewer impacts on social services, and lower costs. However, it may also result in higher long-term releases of contaminants to the groundwater and may result in increased potential health effects to future potential users of the Hanford Site.

Effects on Groundwater

Contaminates would enter the groundwater from releases during retrieval and precipitation infiltrating through the residual waste in the tanks and the low-activity waste vaults. Although groundwater modeling has not been performed for this variation, the effects were estimated by comparing it to the Ex Situ/In Situ Combination alternative. This comparison shows that the groundwater effects would be somewhat greater than the Ex Situ/In Situ Combination alternative. It would be expected that there would be exceedances of groundwater standards for this variation to the Ex Situ/In Situ Combination alternative.

Anticipated Risk

Anticipated Risk During Remediation

The radiological and toxicological risk during remediation would result from air emissions and direct exposure from continued operations (including tank farm and evaporator operations), retrieval, separations and treatment (including vitrification, evaporator, and gravel fill operations), transportation (including truck transport of tank waste residuals and rail transport of vitrified high-level waste to a geologic repository), storage and disposal, monitoring and maintenance, and closure and monitoring. Because the facilities would process less waste, require fewer workers, and transport less high-level waste to a geologic repository than the Ex Situ/In Situ Combination alternative, the anticipated risks would be less than those calculated for the Ex Situ/In Situ Combination alternative.

Anticipated Risk After Remediation

By retrieving 23 selected tanks under this variation of the Ex Situ/In Situ Combination alternative, 85 percent of Tc-99, 79 percent of C-14, and 66 percent of I-129 would be retrieved rather than 90 percent as with the Ex Situ/In Situ Combination alternative. The long-term risk of contracting a fatal cancer from consumption of contaminated groundwater would be somewhat higher than those calculated for the Ex Situ/In Situ Combination alternative, which has a maximum risk of 3 in 1,000 at 5,000 years in the future for an onsite farmer.

Potential Accidents

Nonradiological/Nontoxicological Accidents

Occupational accidents from construction and operations as well as transportation accidents would be expected to be less than those calculated for the Ex Situ/In Situ Combination alternative because the workforce would be smaller.

Radiological/Toxicological Accidents

Operation activities would be similar to the Ex Situ/In Situ Combination alternative, therefore latent cancer fatalities and chemical exposures resulting from operation accidents during routine operations, retrieval, pretreatment, and treatment would be the same as those analyzed for the Ex Situ/In Situ Combination alternative.

6.0 REGULATORY COMPLIANCE

This variation of the Ex Situ/In Situ Combination alternative would involve the same regulatory compliance issues as the Ex Situ/In Situ alternative presented in the EIS. Implementing this alternative would require changes to the land disposal restrictions of the Resource Conservation and Recovery Act, the HLW disposal requirements of the Nuclear Regulatory Commission, and DOE's policy for disposal of readily retrievable high-level waste in a geologic repository.

NEPA COVER SHEET

TITLE: Draft Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington

RESPONSIBLE AGENCIES: Lead Federal Agency: U.S. Department of Energy (DOE), Richland Operations Office; Lead State Agency: Washington State Department of Ecology (Ecology).

ABSTRACT: This document analyzes the potential environmental consequences related to the Hanford Site Tank Waste Remediation System (TWRS) alternatives for management and disposal of radioactive, hazardous, and mixed waste. This waste is currently or projected to be stored in 177 underground storage tanks and approximately 60 miscellaneous underground storage tanks, and the management and disposal of approximately 1,930 cesium and strontium capsules located at the Hanford Site. This document analyzes the following alternatives for remediating the tank waste: No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification, Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, and Ex Situ/In Situ Combination. This document also addresses a Phased Implementation alternative (the DOE and Ecology preferred alternative for remediation of tank waste). Alternatives analyzed for the cesium and strontium capsules include: No Action, Onsite Disposal, Overpack and Ship, and Vitrify with Tank Waste. At this time, DOE and Ecology do not have a preferred alternative for the cesium and strontium capsules.

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PUBLIC COMMENT: Public meetings on the TWRS Draft Environmental Impact Statement will be held at times, dates, and locations that will be announced separately. Written and oral comments on the TWRS Draft Environmental Impact Statement will be accepted until May 28, 1996 at the Richland, Washington address and facsimile or Electronic Mail numbers provided. DOE and Ecology will consider all public comments in preparing the TWRS Final Environmental Impact Statement, which is scheduled to be issued in July 1996.

SEPA FACT SHEET

DOCUMENT TITLE AND LOCATION OF PROJECT: Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington

PROPONENT: U.S. Department of Energy

ABSTRACT: This document analyzes the potential environmental consequences related to the Hanford Site Tank Waste Remediation System (TWRS) alternatives for management and disposal of radioactive, hazardous, and mixed waste. This waste is currently or projected to be stored in 177 underground storage tanks and approximately 60 miscellaneous underground storage tanks, and the management and disposal of approximately 1,930 cesium and strontium capsules located at the Hanford Site. This document analyzes the following alternatives for remediating the tank waste: No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification, Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, and Ex Situ/In Situ Combination. This document also addresses a Phased Implementation alternative (the DOE and Ecology preferred alternative for remediation of tank waste). Alternatives analyzed for the cesium and strontium capsules include: No Action, Onsite Disposal, Overpack and Ship, and Vitrify with Tank Waste. At this time, DOE and Ecology do not have a preferred alternative for the cesium and strontium capsules.

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ISSUE DATE: April 12, 1996

PUBLIC COMMENT: Public meetings on the TWRS Draft Environmental Impact Statement will be held at times, dates, and locations that will be announced separately. Written and oral comments on the TWRS Draft Environmental Impact Statement will be accepted until May 28, 1996 at the Richland, Washington address and facsimile or Electronic Mail numbers provided. DOE and Ecology will consider all public comments in preparing the TWRS Final Environmental Impact Statement, which is scheduled to be issued in July 1996.

POTENTIAL PERMITS REQUIRED:

Activity and Waste Type	Regulatory Action Required	Regulation	Regulatory Agency
Air emissions	Radiation Air Emissions Program (Approval)	Washington Administrative Code 246-247	Washington State Department of Health
Air emissions	Controls for New Sources of Toxic Air Pollutants (Approval)	Washington Administrative Code 173-460 and 40 Code of Federal Regulations (CFR) 61	Ecology and EPA
Air emissions	Notice of Construction and possible modification to the Sitewide permit (Approval)	Washington Administrative Code 173-400 and 173-460	Ecology and Benton County Clean Air Authority
Air emissions	Ambient Air Quality Standards and Emissions Limits for Radionuclides (Approvals)	Washington Administrative Code 173-480	Ecology
Soil column waste water disposal	State Waste Discharge Permit (Permit)	Washington Administrative Code 173-216	Ecology
Effluent, spills	Groundwater Quality Standards (Approval and possible permit)	Washington Administrative Code 173-200	Ecology
Effluent	Water Quality Standards for Surface Waters (Permit)	Washington Administrative Code 173-201A	Ecology
Effluent	National Pollutant Discharge Elimination System Permit Program (Permit)	Washington Administrative Code 173-226-100	Ecology
Dangerous (including mixed) waste generation, storage, treatment, and disposal	Dangerous Waste Permit, RCRA Permit (Permit)	Washington Administrative Code 173-303 and 40 CFR 260-270	Ecology and EPA
All media	Cultural Resource Review Clearance	36 CFR 800	DOE and Washington State Historic Preservation Officer
All media	Endangered Species Review	50 CFR 402.6	U.S. Fish and Wildlife Service
Onsite management and disposal of high-level and transuranic waste	Waste Disposal Review and Standards (Approval)	40 CFR 191	EPA

DATES FOR FINAL ACTIONS: The anticipated availability of the TWRS Final Environmental Impact Statement is July 1996. The TWRS Record of Decision is anticipated in August 1996. The Record of Decision will be published in the Federal Register.

RELATED DOCUMENTS: Environmental Impact Statement technical reports, background data, materials incorporated by reference, and other related documents are available either through the contacts listed in the Contact Section, or at:

DOE Freedom of Information
Reading Room
Forrestal Building
1000 Independence Ave. S.W.
Washington, D.C.

DOE Public Reading Room
Washington State University
Tri-Cities Branch
100 Sprout Road
Richland, WA

and at the following U.S. Department of Energy information repositories:

University of Washington
Suzzallo Library
Government Publication Room
Seattle, WA

Gonzaga University
Foley Center
E. 502 Boone
Spokane, WA

Portland State University
Bradford Price Millar Library
SW Harrison and Park
Portland, OR

Copies of the Environmental Impact Statement are available free of charge to the interested public through the contacts listed in the Contact Section.

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TANK WASTE REMEDIATION SYSTEM
ENVIRONMENTAL IMPACT STATEMENT
PURPOSE AND NEED FOR ACTION

This EIS addresses actions proposed by DOE to manage and dispose of radioactive, hazardous, and mixed waste within the Tank Waste Remediation System program at the Hanford Site in southeastern Washington State. The waste includes more than 212 million liters (56 million gallons) of waste stored or to be stored in underground storage tanks at the Hanford Site. DOE also proposes to manage and dispose of cesium and strontium contained in approximately 1,930 capsules most of which are currently stored at the Site. DOE must implement long-term actions to safely manage and dispose of the tank waste, associated miscellaneous underground storage tanks, and the cesium and strontium capsules to permanently reduce potential risk to human health and the environment. These actions also are needed to ensure compliance with Federal and Washington State laws regulating the management and disposal of radioactive, hazardous, and mixed waste. Federal and State laws and regulations require DOE to safely manage the tank waste and encapsulated cesium and strontium, and to dispose of high-level and low-activity waste.

S.1 INTRODUCTION

The National Environmental Policy Act (NEPA) requires Federal agencies to analyze the potential environmental impacts of their proposed actions to assist them in making informed decisions. A similar Washington State law, the State Environmental Policy Act (SEPA), requires State agencies, including the Washington State Department of Ecology (Ecology), to analyze environmental impacts before making decisions that could impact the environment. A major emphasis of both laws is to promote public awareness of these actions and provide opportunities for public involvement. Because NEPA and SEPA requirements are similar, the U.S. Department of Energy (DOE) and Ecology have agreed to co-prepare this Environmental Impact Statement (EIS) to streamline the environmental review process.

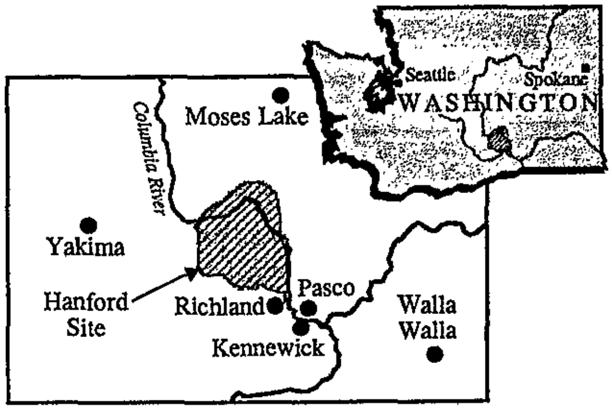
An EIS is prepared in a series of steps: compiling Federal and State agency, Tribal Nation, and public comments to define issues requiring analysis (a process known as scoping); preparing the Draft EIS; receiving and responding to public comments on the Draft EIS; and preparing the Final EIS.

An EIS does not make decisions; rather, it is one of several sources of information that decision makers consider in making a decision on a proposed action. The final step in the NEPA process is issuing a Record of Decision on the proposed action, which documents the decisions made by the agency.

DOE is the Federal agency responsible for waste management and environmental restoration at the Hanford Site near Richland, Washington (Figure S.1.1). The proposed Federal action analyzed in this EIS is the management and disposal of Tank Waste Remediation System (TWRS) radioactive, hazardous, and mixed waste. This waste is stored in 177 large underground storage tanks and in approximately 60 smaller active and inactive miscellaneous underground storage tanks. The proposed Federal action also includes managing and disposing of approximately 1,930 cesium and strontium capsules stored in the Waste Encapsulation and Storage Facility.
The proposed State action is the permitting of proposed waste management and disposal facilities for the tank waste and cesium and strontium capsules. The tank waste and cesium and strontium capsules currently pose a low short-term risk to human health and the environment; however, storage costs are high, and the potential for an accident resulting in large releases of radioactive and chemical contaminants will increase as the facilities age. In addition, there are regulatory requirements that require the waste to be remediated.

DOE and Ecology conducted a scoping process from January 23, 1994 to March 15, 1994 to define the issues for analysis in the EIS and have prepared this Draft EIS based in part on comments from Federal and State agencies, Tribal Nations, and the public. Comments on this Draft EIS will be considered during preparation of the Final EIS. NEPA requires a minimum 45-day comment period after issuance of the Draft EIS. After the Final EIS is published, a minimum 30-day waiting period is required before a final decision can be issued in a Record of Decision.

Figure S.1.1 Hanford Site and Vicinity Map



National Environmental Policy Act and Washington State Environmental Policy Act Terms

Alternatives: The range of reasonable alternatives, including the No Action alternative, considered in selecting an approach to meet the need for agency action.

Environmental Impact Statement: A detailed environmental analysis for a proposed action that could significantly affect the quality of the human and natural environment. A tool to assist in decision making, it describes the positive and negative environmental effects of the proposed action and its alternatives.

Record of Decision: A public record of the agencies' decision that provides a discussion of the decision, identifies the alternatives considered (specifying which were considered environmentally preferable), and indicates whether all practicable means to avoid or minimize environmental harm from the selected alternative were adopted (and if not, why they were not).

S.2 BACKGROUND

From 1943 to 1989, the Hanford Site's principal mission was the production of weapons-grade plutonium. To produce plutonium, uranium metal was irradiated in a plutonium production reactor.

The irradiated uranium metal, also known as spent fuel, was cooled and treated in a chemical separations or reprocessing plant, where plutonium was separated from uranium and many other radioactive by-products. The plutonium then was used for nuclear weapons production. Large amounts of spent fuel were produced to generate enough plutonium to make a nuclear weapon. The chemical separations processes resulted in large volumes of radioactive waste.

The Hanford Site processed more than 100,000 metric tons (110,000 tons) of uranium and generated several hundred thousand metric tons of waste. The waste included high-level, transuranic, low-level, hazardous, and mixed waste; waste that includes both radioactive and hazardous waste. The waste was managed in compliance with the laws and regulations applicable at the time, but major changes in laws and regulations governing waste management and disposal have mandated changes in the waste management program.

For the high-level waste generated by the chemical reprocessing plants, waste management initially involved adding sodium hydroxide or calcium carbonate to make the acidic waste alkaline and storing the waste in large underground tanks until a long-term disposal solution could be found. In the 1940's through the early 1960's, 149 single-shell tanks

Tank Waste Remediation System Waste Types

Waste must be managed, treated, stored, and disposed of differently according to the waste type, degree of risk posed to humans or the environment, and its source. Waste in the tank farm system includes the following waste types.

The most dangerous radioactive waste is **high-level waste**, a by-product of reprocessing spent nuclear fuel. This waste requires radiation shielding, special handling techniques, and when disposed of, special measures to isolate it from humans and the environment.

Transuranic waste is material contaminated with radioactive elements with an atomic number greater than uranium. This waste does not require the same degree of isolation as high-level waste; however, it cannot be disposed of in a near-surface facility.

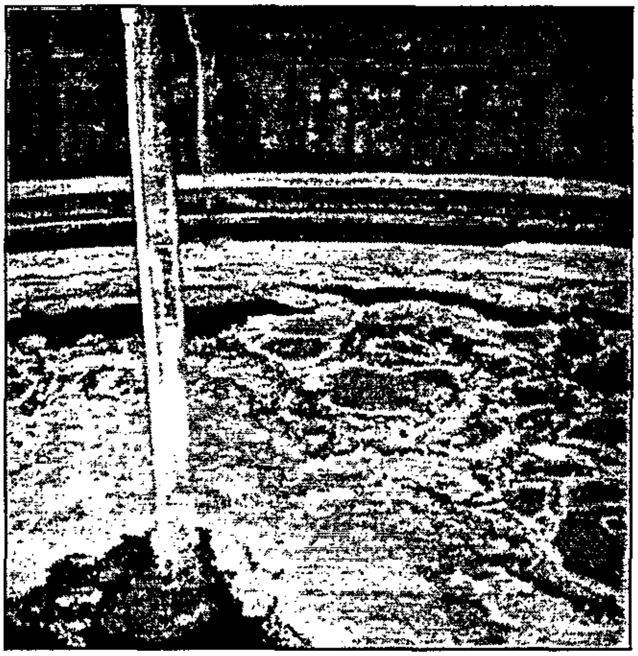
The least dangerous radioactive waste is **low-level or low-activity waste** (also known as **incidental waste**). It consists of all radioactive waste that is not high-level or transuranic waste. Low-level waste includes waste that did not originate from nuclear fuel processing, but is the residual product of high-level waste from which as much of the radioactivity as practical has been removed.

Hazardous or dangerous waste is ignitable, corrosive, reactive, toxic, persistent in the environment, exhibits dangerous characteristics, or appears on special EPA lists. The waste may cause or contribute to an increase in health hazards when improperly treated, stored, transported, disposed of, or otherwise managed.

Mixed waste is waste that is both hazardous or dangerous and radioactive.

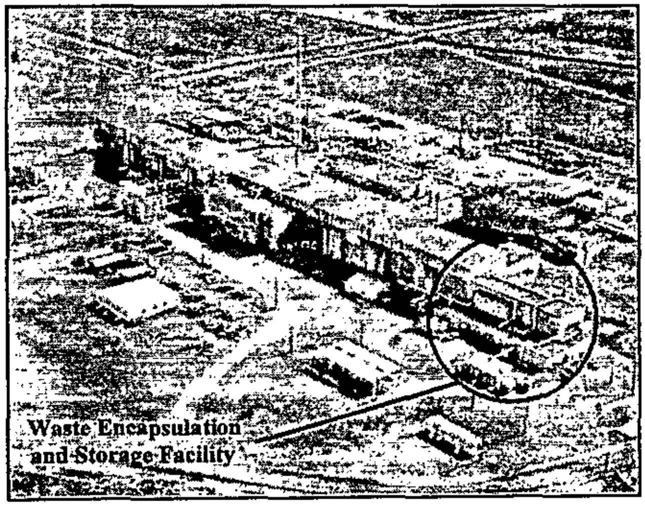
with a capacity of 210,000 liters (55,000 gallons) to 3,800,000 liters (1,000,000 gallons) were built to store high-level waste in a region near the center of the Hanford Site referred to as the 200 Areas.During the 1950's, uranium was extracted from the single-shell tanks for reprocessing, an action that introduced new chemicals to the tanks. Also, to free up tank space for large volumes of new waste generated by fuel reprocessing, chemicals were added to the tanks to settle many of the radionuclides to the bottom of the tanks. This left the upper liquid layer less radioactive allowing large volumes of liquid waste to be siphoned off as low-activity waste. Additionally, several single-shell tanks were built with piping connections that allowed waste to flow from one tank to another, separating or settling most of the solids from the liquid waste. The low-activity liquid waste that resulted was sent to shallow subsurface drainfields, referred to as cribs, where it percolated into the soil. This process resulted in higher concentrations of heat-generating cesium-137 and strontium-90 in the tanks, which threatened the integrity of the tanks.

Tank Contents Vary from Tank to Tank



The tanks contain various radionuclides and chemicals that have separated into blended layers of vapors, liquids, slurries, sludges, and saltcake.

B Plant - Waste Encapsulation and Storage Facility

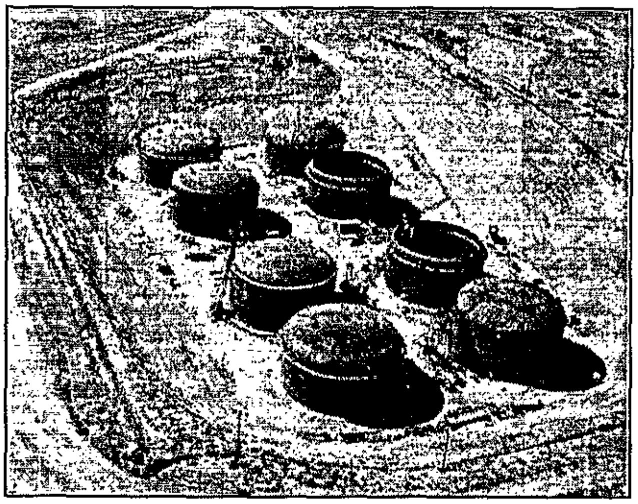


Cesium and strontium capsules are stored in the Waste Encapsulation and Storage Facility (circled), which is attached to B Plant, an inactive reprocessing plant.

Heat generation in the tanks was addressed in the 1960's when single-shell tank waste was recovered and sent to B-Plant to remove cesium and strontium from the waste. Cesium and strontium then were converted to salts, placed in capsules, and stored in a separate facility as waste by-product. Most of these capsules currently are stored at the Hanford Site in water basins at the Waste Encapsulation and Storage Facility. Some of the capsules were sent offsite to be used as heat or radiation sources. These capsules are scheduled to be returned to the Site by mid-1996.

The single-shell tanks had a design life of approximately 20 years. Leakage of waste from the single-shell tanks to the underlying soil was suspected in 1956 (from tank 104-U) and confirmed in 1961. By the late 1980's, 67 of the single-shell tanks were known or suspected leakers, and an estimated 3.8 million liters (1 million gallons) of high-level waste had been released to the soil beneath the 200 Areas. To address concerns with the design of single-shell tanks, the Hanford Site adopted a new double-shell tank design that includes an outer steel shell to contain any leaks that occur through the inner steel shell. The double-shell tank design provides for leak detection and recovery before waste could reach the surrounding soil.

Double-Shell Tanks Under Construction in 1984

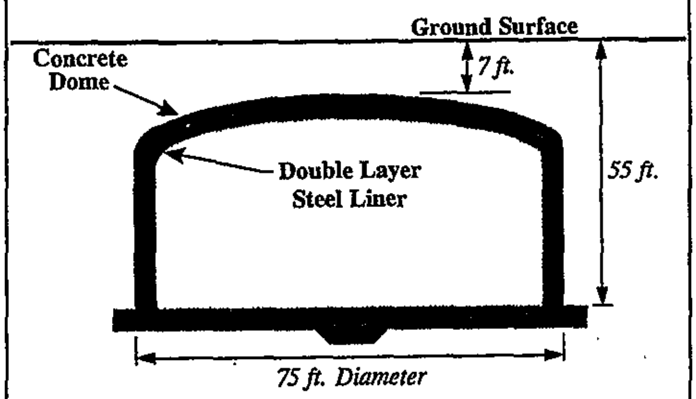


To provide better leak protection than single-shell tanks, 28 one-million-gallon double-shell tanks were constructed at the Hanford Site between 1968 and 1986.

Between 1968 and 1986, 28 double-shell tanks with a capacity of 3,800,000 liters (1,000,000 gallons) to 606,000 liters (160,000 gallons) were constructed in the 200 Areas. Most free-standing liquid contained in the single-shell tanks has been pumped into double-shell tanks, however, the remaining solids still contain liquids within the void spaces. Newly generated waste is stored in the double-shell tanks. No leaks are known to have occurred from the double-shell tanks.

Tanks were constructed in groups called tank farms. The current tank farm system consists of 177 large underground storage tanks in 18 tank farms. These tanks include 149 single-shell tanks and 28 double-shell tanks (Figure S.2.2) that contain a total of 212 million liters (56 million gallons) of liquid, sludge, and saltcake (generally a semi-solid crusty material).

Figure S.2.2 Tank Schematic



Of the 177 tanks at Hanford, 28 are double-shell tanks. The 149 single-shell tanks have only one steel liner. Both types of tanks have a concrete shell in addition to steel liners.

There also are approximately 60 smaller active and inactive miscellaneous underground storage tanks. Much of the waste in the inactive tanks has been removed or stabilized, and the remaining waste is similar to the waste in the double- and single-shell tanks. The active tanks primarily are used to facilitate waste transfers. Additional waste, which is planned for storage in the double-shell tanks, includes radioactive and hazardous waste from other Hanford Site cleanup and decontamination activities.

S.3 THE HANFORD SITE ENVIRONMENT

The Hanford Site is in the semi-arid region of southeastern Washington State and occupies about 1,450 square kilometers (560 square miles) north of Richland, Washington. Population centers within 80 kilometers (50 miles) of the Hanford Site are Yakima to the west and the Tri-Cities of Richland, Kennewick, and Pasco to the southeast. Approximately 450,000 people reside within an 80-kilometer (50-mile) radius of the 200 Areas. The Hanford Site is a major contributor to the economy of the Tri-Cities, accounting for approximately 25 percent of all nonfarm jobs in 1994. Historically, changes in the Hanford Site's mission and employment levels have had large impacts on the economy of the Tri-Cities area.

Land adjacent to the Hanford Site principally is range and agricultural land except for the area on the southeast corner of the Site where the city of Richland is located. The Columbia River flows through the northern part of the Site and forms part of the Site's eastern boundary. The stretch of the Columbia River that flows through the Site is known as the Hanford Reach, and is the last free-flowing segment of the Columbia River in the United States. The Hanford Reach has been proposed as a Recreational River under the Wild and Scenic Rivers Act. The Columbia River's many uses include irrigation water for area farms and drinking water for communities downriver of the Hanford Site. The river is approximately 11 kilometers (7 miles) from the 200 Areas.

The Shrub-Steppe Habitat

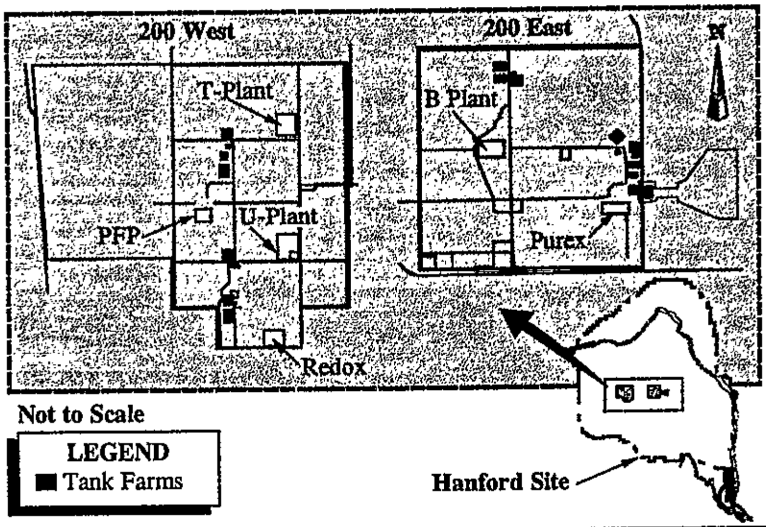
The Hanford Site is home to a large undisturbed shrub-steppe area, which is a valuable vegetation and wildlife habitat.

About 6 percent of the Hanford Site has been used for defense production and waste management purposes. Because much of the Hanford Site has been undisturbed for nearly 50 years, the Site contains one of the largest remaining relatively undisturbed shrub-steppe habitat areas in Washington State.

Shrub-steppe habitat is vegetation that flourishes on arid lands in areas with extreme temperature ranges. Shrub-steppe is considered a priority habitat by Washington State because of its importance to sensitive wildlife. About one-half of the land located on the Hanford Site has been designated as an ecological study area or wildlife refuge. These areas include the Fitzner Eberhardt Arid Lands Ecology Reserve located south and west of the 200 Areas and areas north of the Columbia River.

The tank waste and the Waste Encapsulation and Storage Facility are located in the 200 Areas near the center of the Hanford Site on the Central Plateau (Figure S.3.1).

Figure S.3.1 Central Plateau and 200 Areas



200 Areas Waste Overview

The 200 Areas of the Central Plateau, where the waste tanks and cesium and strontium capsules are located, have been used extensively for fuel reprocessing, waste management, and disposal activities. In addition to the waste tanks and capsules, the 200 Areas are the location of several inactive fuel processing facilities, buried solid waste, and irradiated fuel storage. The 200 Areas also are the location of 43 of the Hanford Site's 72 Superfund sites (past waste disposal or release sites requiring investigation and potential remediation), nearly 2,500 hectares (6,200 acres) of surface contamination, and past contaminant releases to the ground, which have resulted in groundwater contamination plumes that underlie approximately 520 square kilometers (200 square miles) of the Site.

More than 80 percent (391 million curies) of the Hanford Site's radionuclides are estimated to be located in the 200 Areas. Of the radionuclides in the 200 Areas, the waste in the tanks (208.5 million curies) and the cesium and strontium capsules (173.5 million curies) account for approximately 97 percent of the inventory. Another 1.4 million curies are estimated to have been released or leaked to the ground, approximately 4.9 million curies have been disposed of in solid waste burial grounds, and 2.6 million curies are stored in solids or contained in irradiated fuel storage. The TWRS EIS addresses only management and disposal of tank waste and the cesium and strontium capsules.

Other waste disposal activities in or near the 200 Areas that are not addressed in this Draft EIS include the following:

- Site waste from the Environmental Restoration program to be disposed of in the Environmental Restoration Disposal Facility
- Commercial low-level waste disposed of at the US Ecology site.

Much of the defense production activity occurred in the 200 Areas, and therefore, much of the land in the 200 Areas is disturbed.
The 200 Areas also are the location of large low-level waste burial grounds. The 200 Areas and the surrounding Central Plateau have been identified as potential exclusive-use waste management areas to support the Hanford Site's waste management and environmental restoration programs. Because of past disturbances in the 200 Areas, the shrub-steppe habitat and wildlife typically found in that habitat, as well as archeological sites, are limited.

Groundwater occurs beneath the 200 Areas at a depth of 70 to over 90 meters (230 to over 300 feet) below the ground surface. Past production and disposal practices resulted in extensive contamination in various concentrations in the soils beneath the 200 Areas. Contributors to the contamination were tank waste management practices that resulted in releases of liquid from the tanks as well as leaks from the tanks. Radioactive and nonradioactive contamination occurs in various concentrations in the soils beneath the 200 Areas, especially near the waste management facilities and the locations of unplanned releases. Over time, the contaminants in the soils have been carried down to the groundwater and toward the Columbia River.

At least 12 different contaminants have been identified in the groundwater beneath the 200 Areas. Contaminants include arsenic, chromium, cyanide, carbon tetrachloride, cobalt-60, strontium-90, technetium-99, iodine-129, cesium-137, tritium, and plutonium-239 and -240.

Radiation

Radiation is produced by unstable atoms that give off energy or particles (radiation) in a process called **radioactive decay**. An atom that emits radiation is called a **radioisotope or radionuclide.** Over time, radionuclides decay until a stable atom is produced. This can occur over a few minutes, days, or years; in some cases, over millions of years.

The measure of radiation exposure or dose that indicates the potential damage to individual human cells is the **rem.** The average American is exposed to about 360 millirem (0.36 rem) per year, mostly from natural sources. One thousand millirem is equal to 1 rem. Natural sources include the earth, water, food, and the human body. About 20 percent of the radiation exposure is from human-made sources such as x-rays, consumer products, and nuclear medicine.

The measure of radiation exposure that indicates the potential damage to human cells for a population is the **person-rem.** The person-rem is the unit for the dose received by the entire population.

Based on the International Commission on Radiological Protection guidelines, the Federal government has set a yearly limit of 5,000 millirem (5 rem) for worker exposure to radiation. The yearly limit for exposure to the public from government actions is 100 millirem (0.1 rem).

The Hanford Site is an attainment area for all criteria pollutants under the Clean Air Act, as amended. However, there are occasional episodes of blowing dust, which typically are the result of recently plowed farmland adjacent to the Hanford Site. Severe natural events such as flooding, earthquakes, and tornadoes are rare in the 200 Areas.

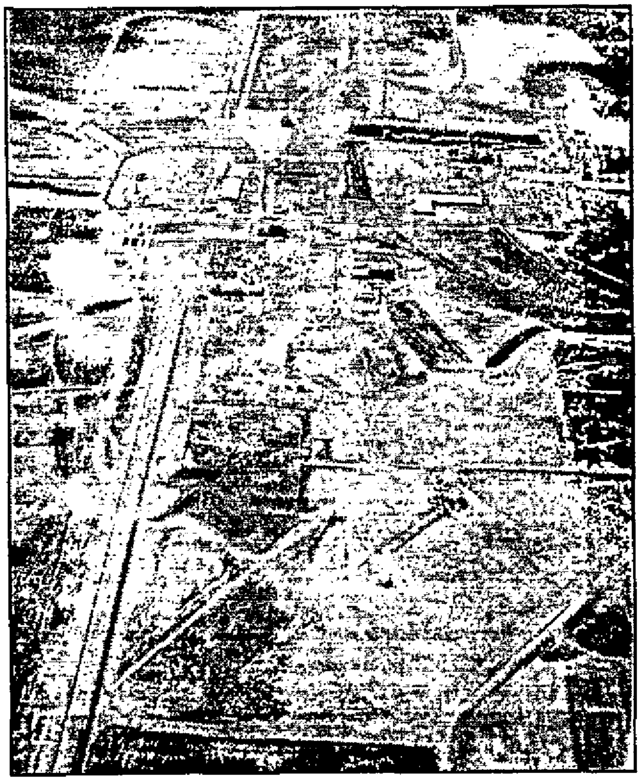
Since the Hanford Site began operation in 1943, it is estimated that the nearby population has received a cumulative population dose of approximately 100,000 person-rem from Hanford Site activities, most of which was received before 1972. In 1994, the estimated annual person-rem dose to the nearby population was 0.6 person-rem from Hanford activities. The cumulative natural background person-rem dose from 1943 to 1994 to the nearby population was an estimated 5 million person-rem, which is an annual dose of approximately 110,000 person-rem.

S.4 REGULATORY HISTORY AND REQUIREMENTS

Throughout much of the history of plutonium production at the Hanford Site there were few laws regulating waste management and environmental protection. Because of national security concerns, nuclear production facilities like the Hanford Site were largely exempted from external regulation. Under the provisions of the Atomic Energy Act of 1954, DOE was authorized to establish standards to protect health and minimize dangers to life or property for activities under DOE's jurisdiction. In the 1970's and 1980's, new environmental laws were enacted regulating waste management, storage and disposal, and pollution emissions to the air and water. In more recent years other agencies became responsible for regulating many aspects of DOE's activities, particularly waste management and remediation.

In response to the continued accumulation of spent nuclear fuel, high-level radioactive waste, other hazardous wastes, and a growing public awareness and concern for public health and safety, Congress passed numerous laws including the Nuclear Waste Policy Act. The purpose of these laws was to establish a national policy and program that would provide reasonable assurance that the public and the environment would be adequately protected from the hazards posed by these wastes. The action by Congress was

Aerial View of 200 Areas Tank Farms



At the Hanford Site, there are 177 underground tanks clustered in 18 tank farms in the 200 Areas of the Central Plateau. The tanks are buried approximately 3 meters (10 feet) under the soil, with monitoring equipment and access ports above the ground.

influenced by a national consensus that, because of potential hazards, spent nuclear fuel and high-level waste needed to be permanently isolated from the human environment with minimal reliance on institutional controls. Permanent isolation consists of placing the waste within engineered and natural barriers that are likely to contain the material for a long time. Minimal reliance on institutional controls means the isolation is not dependent on ongoing maintenance of facilities, human attention, or commitment by governments or other institutions. The national consensus has been reflected in the northwest by strong support from DOE, Federal and State agencies, Tribal Nations, and citizens and stakeholders to accomplish cleanup of the Hanford Site.

In 1974, Congress passed the Energy Reorganization Act, which authorized the Nuclear Regulatory Commission to regulate and license DOE facilities authorized for the express purpose of long-term storage of high-level radioactive waste that are not part of DOE's research and development program. The Nuclear Regulatory Commission established regulations for low-level radioactive waste that can be disposed of in land disposal sites (10 Code of Federal Regulations [CFR] Part 61), as well as radioactive waste requiring geologic disposal (10 CFR Part 60). The U.S. Environmental Protection Agency (EPA) was authorized to establish standards for managing and disposing of spent nuclear fuel, high-level waste, and transuranic waste. These standards are contained in 40 CFR Part 191 and would apply if high-level waste is disposed of at the Hanford Site.

In addition to applicable laws and regulations, DOE has established a set of policies to guide DOE activities. It is DOE policy that new and readily retrievable existing high-level waste be processed into an immobilized form for disposal in a potential geologic repository. High-level waste that is not readily retrievable shall be evaluated for in-place stabilization or disposal in a potential geologic repository. DOE's policy for low-level waste is that it be disposed of at the site where it is generated, if practicable. If onsite disposal capacity is not available, the low-level waste shall be disposed of at an offsite DOE disposal facility.

Major TWRS Regulatory Compliance Requirements

The regulatory changes that have occurred since the 1970's have greatly altered the way DOE manages and disposes of the Hanford Site's tank waste. The major laws, regulations, and agreements that would affect which tank waste management and disposal alternative DOE can implement include the following:

- Clean Air Act
- Clean Water Act
- Resource Conservation and Recovery Act
- Washington State Hazardous Waste Management Act
- Atomic Energy Act
- Nuclear Waste Policy Act
- Tri-Party Agreement.

The Clean Air Act, as amended, requires DOE to meet national air quality standards, ensure that hazardous air emissions from existing and new sources are controlled to the extent practical, and obtain an operating permit for all major emission sources. The Clean Water Act and the Safe Drinking Water Act, as amended, regulate discharges to surface water, set national drinking water standards, and regulate emissions of hazardous constituents to surface and groundwater.

With the passage of the Resource Conservation and Recovery Act of 1976 as amended by the Hazardous and Solid Waste Amendments of 1984, and the Federal Facility Compliance Act of 1992, the EPA and states were authorized to regulate hazardous and mixed waste generation, treatment, storage, and disposal. The Resource Conservation and Recovery Act does not apply to Atomic Energy Act materials (source, special nuclear, and by-product material) but in 1987 mixed waste at DOE facilities was determined to be covered by the Resource Conservation and Recovery Act regulations. The Federal Facilities Compliance Act of 1992 amended the Resource Conservation and Recovery Act to define mixed waste as waste that contains both hazardous waste and source, special, and by-product material. In November 1987, Ecology, the administrating agency for the State Hazardous Waste Management Act, was authorized by EPA to administer state statutes in lieu of the Resource Conservation and Recovery Act. These regulations established regulations for newly generated hazardous waste but as originally enacted did not address past waste disposal practices.

To clean up past hazardous and radioactive waste disposal sites, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986. This law required Federal agencies to investigate and remediate releases of hazardous substances (including radioactive contaminants) from their facilities.

In 1986, regulators from EPA, Ecology, and DOE's Richland Operations Office began to examine how best to bring the Hanford Site into compliance with the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Act. The regulators and DOE agreed to develop one compliance agreement that set agreed-upon milestones for cleaning up releases of hazardous substances. Negotiations concluded in late 1988, and the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) was signed by the three agencies on January 15, 1989. The Tri-Party Agreement is the primary framework for the regulation of tank waste remediation. The existing waste, as well as new waste added to the tank farms, is regulated by the Tri-Party Agreement's Resource Conservation and Recovery Act enforcement provisions.

Tri-Party Agreement

The Tri-Party Agreement is an enforceable agreement among DOE, Ecology, and EPA for achieving environmental compliance at the Hanford Site. The agreement accomplishes the following:

- Defines Comprehensive Environmental Response, Compensation, and Liability Act cleanup provisions for past contamination
- Defines Resource Conservation and Recovery Act waste treatment, storage, and disposal requirements and corrective actions for waste management
- Establishes responsibilities for each agency
- Provides a basis for budgeting
- Establishes enforceable milestones for achieving cleanup and regulatory compliance.

In 1988, after completing the Hanford Defense Waste EIS, DOE decided to proceed with preparing the double-shell tank waste for final disposal. Subsequent to this decision, the following important changes occurred in the Tank Waste Remediation System program for managing the disposal of the tank waste.

- B Plant, selected in the Hanford Defense Waste Record of Decision as the facility for pretreatment processes to comply with current environmental and safety requirements, was found not to be viable or cost effective to operate.
- The Tri-Party Agreement was signed in 1989, establishing a revised approach for achieving environmental compliance at the Hanford Site including specific milestones for the retrieval, treatment, and disposal of tank waste.
- Safety issues were identified for approximately 50 double-shell and single-shell tanks, which became classified as Watchlist tanks in response to the 1990 enactment of Public Law 101-510.
- The planned grout project for immobilizing low-activity waste was terminated, and a vitrified waste form was adopted as the proposed approach as a result of concerns with the adequacy of disposal of low-activity waste in near-surface vaults.
- The planning basis was revised to retrieve waste from all underground storage tanks, including the single-shell tanks, and treat the retrieved single-shell tank waste in combination with the double-shell tank waste.
- The construction of the Hanford Waste Vitrification Plant was delayed because of insufficient capacity to vitrify the high-level waste fraction of all double-shell and single-shell tank waste in the planned time frame.

These changes and further research on the tank waste and remediation technologies resulted in an extensive reevaluation of the waste treatment and disposal plan that culminated in adopting a revised strategy to manage and dispose of tank waste. In 1994, DOE, Ecology, and EPA modified the Tri-Party Agreement to incorporate the new strategy for remediating the tank waste. The revised technical strategy embodied in the Tri-Party Agreement addressed the need to manage and dispose of tank waste because the waste has an unacceptable potential for release to the environment and thereby poses a risk to human health and the environment. The risk posed by tank waste includes both urgent tank safety issues and longer-term risk.

To address the urgent safety issues, the Safe Interim Storage of Hanford Tank Wastes EIS was prepared as an interim action EIS to consider alternatives for maintaining safe storage of tank waste. The actions considered in the EIS included interim actions to mitigate the generation of high concentrations of flammable gases in tank 101-SY and interim stabilization of older single-shell tanks, many of which have leaked. The most pressing interim need identified by DOE and Ecology was for a safe, reliable, and regulatory compliant replacement cross-site transfer capability to move waste between the 200 West and 200 East Area tank farms.

On December 1, 1995, DOE published a Record of Decision in the Federal Register (60 FR 61687). The decision was to do the following.

- Construct and operate a replacement cross-site transfer pipeline system.
- Continue to operate the existing cross-site transfer pipeline system on a limited basis until the replacement system is operational.
- Continue to operate the mixer pump in tank 101-SY to mitigate the unacceptable accumulation of hydrogen and other flammable gases.
- Perform activities to mitigate the loss of shrub-steppe habitat.

Relationship of the Safe Interim Storage EIS Record of Decision and the TWRS EIS

The Safe Interim Storage EIS Record of Decision resulted in a decision to construct a replacement cross-site transfer system to transfer waste from the 200 West Area tank farms to double-shell tanks in the 200 East Area. These transfers will be undertaken to address urgent waste storage concerns and will involve only a small percentage of the total waste volume in the 200 West Area.

Several TWRS EIS alternatives would involve the transfer of tank waste from the 200 West Area tank farms to the 200 East Area for waste separation and immobilization. These waste transfers would be made via the replacement cross-site transfer system to move the waste from the 200 West Area to the 200 East Area. The TWRS EIS examines the potential environmental impacts associated with the transfer of this waste.

In 1995, the agencies began negotiating changes to the Tri-Party Agreement to allow private companies to perform remediation of the tank waste in response to a DOE initiative to encourage industry to use innovative approaches to remediate the tank waste. The goal of the privatization effort is to streamline the Tank Waste Remediation System mission, transfer a share of the responsibility, accountability, and liability for successful performance to industry, improve performance, and reduce cost without sacrificing worker and public safety or environmental protection. The agencies issued these changes in the Tri-Party Agreement for public comment in January 1996.

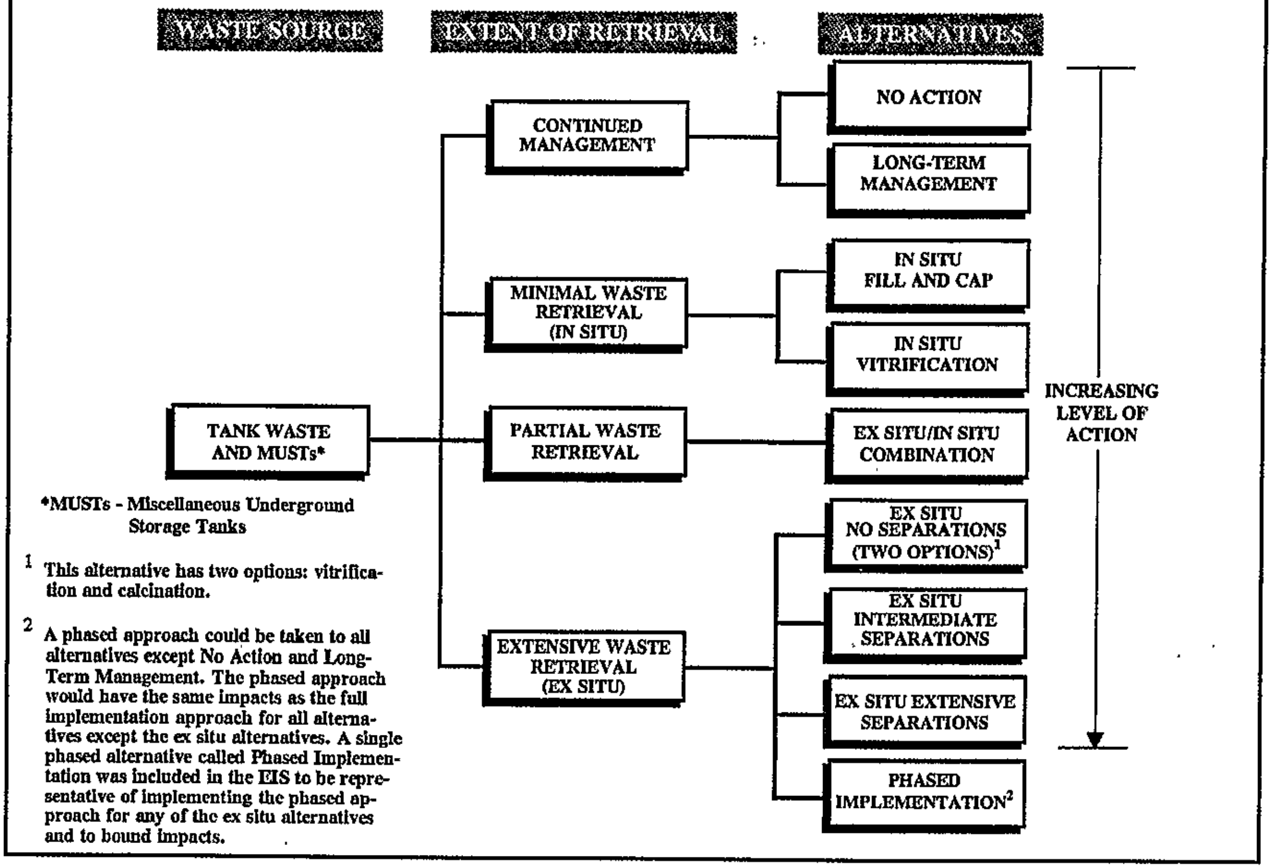
S.5 ALTERNATIVES CONSIDERED IN THE EIS

S.5.1 Tank Waste Alternatives

A wide variety of potential alternatives and combinations of alternatives exist for treating and disposing of the tank waste. One of the challenges for DOE and Ecology is to develop a range of reasonable alternatives for detailed analysis and presentation in the Draft EIS. The alternatives presented in the Draft EIS were chosen to be representative of the many possible variations of the alternatives. The EIS contains an analysis of the full range of reasonable alternatives for management and disposal of the Tank Waste Remediation System waste. The continued safe management of the tank farms is included in all of the alternatives. The tank waste alternatives can be grouped into four major categories depending on the extent of waste retrieval as shown in Figure S.5.1. These groups are as follows.

- Continued management alternatives - No retrieval would be performed. Two continued management alternatives were

Figure S.5.1 Tank Waste Alternatives



analyzed; one without replacing double-shell tanks and one with replacing double-shell tanks and upgrading tank farm waste transfer systems to provide long-term management of the double-shell tank liquids.

- Minimal retrieval alternatives - Liquid waste only would be removed from the double-shell tanks and concentrated in an evaporator. The concentrated waste from the evaporator would be returned to the tanks. The solid waste would be disposed of in place in the tanks; referred to as in situ disposal. Two in situ alternatives were analyzed; one without treatment and one with in-tank treatment of the waste.
- Partial retrieval alternatives - The tank waste resulting in the fewest potential environmental impacts would be disposed of in situ. The liquid waste and the portion of the solid waste that would result in the greatest potential long-term groundwater impacts would be retrieved from the tanks. The retrieved waste then would be immobilized and disposed of outside of the tanks; referred to as ex situ disposal. The retrieved portion of the waste would be separated by physical and chemical processing into low-activity and high-level waste. The low-activity waste would be immobilized and disposed of onsite in near-surface concrete vaults and covered with a thick earthen barrier. The high-level waste would be immobilized and stored onsite for eventual shipment to and disposal at a potential geologic repository.

- Extensive retrieval alternatives - All of the solid and liquid waste practicable (assumed for purposes of analysis to be 99 percent) would be retrieved and separated by physical and chemical processing into low-activity waste and high-activity waste. The low-activity waste would be immobilized and disposed of onsite in near-surface vaults and covered with a thick earthen barrier. The high-level waste would be immobilized and stored onsite for eventual shipment to and disposal at a geologic repository. Three extensive retrieval alternatives, with different levels of separations, were analyzed. A fourth alternative was analyzed to present the potential impacts that would occur if DOE chooses to implement an extensive retrieval alternative in phases rather than immediately implementing a full-scale program. This phased approach was analyzed because of the numerous uncertainties associated with the extensive retrieval alternatives.

The EIS was prepared to support decisions on how to dispose of the waste in the tanks. However, closure of the tank farm system after the waste has been remediated, which is interrelated with the decisions to be made on disposition of the waste, is another action required under the Resource Conservation and Recovery Act. Closure is the final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with past leaks from the tanks. Closure is not within the scope of this EIS because there is insufficient information available concerning the amount of contamination to be remediated. The amount and type of waste ultimately remaining in the tanks after remediation affects closure decisions. The Notice of Intent to prepare the Tank Waste Remediation System EIS (59 FR 4052) stated, "The impacts of closure cannot be meaningfully evaluated at this time". DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." However, some of the decisions to be made concerning how to dispose of tank waste may impact future decisions on closure, so the EIS provides information on how tank waste remediation and closure are interrelated. A single and consistent method of closure was assumed for all alternatives to allow for a meaningful comparison of the alternatives. The closure method used for purposes of analysis was closure as a landfill, which includes placing an earthen surface barrierover the tanks after remediation is complete. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval, and an appropriate NEPA review will be completed.

The Nuclear Waste Policy Act, as amended, establishes the planning basis for the development of geologic repositories for disposal of high-level waste and commercial spent nuclear fuel. One of the requirements of the Nuclear Waste Policy Act is that the first geologic repository shall not accept in excess of 70,000 metric tons (77,000 tons) of heavy metal or equivalent prior to operation of a second repository. The current planning basis for the repository program allocates 10 percent, or 7,000 metric tons (7,700 tons) of heavy metal for disposal of DOE-owned spent nuclear fuel and high-level waste. Current planning also assumes that this waste would be contained in approximately 18,000 standard- sized canisters.

There is insufficient capacity in the first repository to accept all Hanford Site high-level waste under almost every alternative. Some of the waste would need to be disposed of at a second geologic repository, or changes in the repository planning basis would be required to allow for more canisters or larger size canisters to be placed in the repository. This planning basis has a substantial impact on repository cost because the current planning basis shows a $360,000 (1995) cost per canister disposed of at the repository. If larger canisters could be used, the repository fees could be substantially reduced.

For purposes of analysis, a potential geologic repository candidate site at Yucca Mountain, Nevada was assumed to be the final disposal site for high-level waste sent offsite for disposal. Yucca Mountain currently is the only site being characterized as a potential geologic repository for high-level waste. If selected as the site for development, it would be ready for acceptance of high-level waste no sooner than 2015. The potential environmental impacts that would occur at the potential geologic repository from the disposal of high-level waste from the Tank Waste Remediation System are not addressed in this EIS. Potential impacts at the repository are

Key Technical Terms

Calcination: The process by which a substance is heated to a high temperature that is below the melting or fusing point. Calcination results in the loss of moisture, organic destruction, and high temperature chemical reactions. The final waste form is a dense powder.

Earthen Barrier: A multi-layer cover consisting primarily of soil, sand, and rock up to 4.6 meters (15 feet) thick that would be placed over waste that would remain onsite. The purpose of the cover is to inhibit infiltration of water and human intrusion into the waste. This barrier is referred to as the Hanford Barrier.

Ex Situ: Ex situ is used in the EIS to describe operations or disposal that occurs out of the tanks.

Immobilization: A process (e.g., vitrification) used to stabilize waste so that contaminants are not readily leachable into groundwater.

In Situ: In situ is used in the EIS to describe operations or disposal activities that occur in the tanks.

Retrieval: Removal of liquid and solid waste from storage tanks.

Separations: Physical and chemical processes to separate tank waste into different waste types such as high level waste and low-activity waste.

Vitrification: A method of immobilizing waste. This process involves adding materials to the waste and heating the waste until it melts. When the mixture cools, a glass is formed that is highly effective in inhibiting the leaching of contaminants.

being addressed in a separate EIS, which DOE will prepare to analyze the site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel and high-level waste at Yucca Mountain.

All of the TWRS EIS alternatives include the continuation of on-going activities to safely manage the tank waste, including removing liquid waste and operating the existing 242-A Evaporator to concentrate waste and provide additional tank storage capacity and waste management flexibility; additional characterization of the waste; maintaining tank safety activities, such as operating waste mixer pumps and transferring waste between the tanks; and other associated monitoring, maintenance, security, and regulatory compliance activities.

All of the alternatives except the No Action alternative include upgrades to the tank farm waste transfer system, which involve the construction of buried waste transfer pipelines and replacement of transfer lines that are not regulatorily compliant. Also under all of the alternatives DOE would continue its policy of continually evaluating the issues associated with the Tank Waste Remediation System and its path forward as additional tank characterization data and process knowledge are obtained.

The tank waste alternatives developed for analysis in the EIS are summarized in Table S.5.1.

Table S.5.1 Summary of Tank Waste Alternatives [1]

Alternative (Time Frame) [2]	Key Features
No Action (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of saltwell liquid from single-shell tanks). • No new waste retrieval, treatment, or disposal actions.
Long-Term Management (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of saltwell liquid from single-shell tanks). • Upgrade tank farm inter- and intra-waste transfer system. • Replace all double-shell tanks starting in 2035 and again in 2085. • Transfer the double-shell tank waste to new tanks.
In Situ Fill and Cap (1997 to 2029)	• Evaporate liquid from double-shell tank waste. • Fill single-shell tanks and double-shell tanks with gravel, and place a thick earthen cover over the tanks. • Dispose of waste onsite in the tanks.
In Situ Vitrification (1997 to 2033)	• Evaporate liquid from double-shell tank waste. • Vitrify waste in single-shell and double-shell tanks in place, and place a thick earthen cover over the tanks. • Dispose of waste onsite.
Ex Situ/In Situ Combination (1997 to 2034)	• Retrieve approximately 50 percent of the waste from single-shell and double-shell tanks (based on the degree of risk posed to human health and the environment). • Dispose of waste remaining in tanks in place as under the In Situ Fill and Cap alternative. • Separate retrieved waste into high-level and low-activity waste streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of low-activity waste onsite in near-surface vaults. • Store high-level waste onsite pending availability of a potential geologic repository. • Dispose of high-level waste offsite at a potential geologic repository.

Table S.5.1 Summary of Tank Waste Alternatives [1] (cont'd)

Alternative (Time Frame) [2]	Key Features
Ex Situ No Separations (1997 to 2037)	• Retrieve all waste practicable (assumed to be 99 percent) from all single-shell and double-shell tanks. • Vitrify or calcine all retrieved waste. • Store high-level waste onsite pending availability of a potential geologic repository. • Dispose of all waste offsite at a potential geologic repository.
Ex Situ Intermediate Separations (1997 to 2034)	• Retrieve all waste practicable (assumed to be 99 percent) from all single-shell and double-shell tanks. • Separate waste into high-level and low-activity waste streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of low-activity waste onsite in near-surface vaults. • Store high-level waste onsite pending availability of a potential geologic repository. • Dispose of high-level waste offsite at a potential geologic repository.
Ex Situ Extensive Separations (1997 to 2030)	• Retrieve all waste practicable (assumed to be 99 percent) from all single-shell and double-shell tanks. • Separate tank waste into high-level and low-activity waste streams (use ion exchange, caustic and acid dissolution, and sorption and solvent extraction). • Vitrify waste streams in separate facilities. • Dispose of low-activity waste onsite in near-surface vaults. • Store high-level waste onsite pending availability of a potential geologic repository. • Dispose of high-level waste offsite at a potential geologic repository.
Phased Implementation (Phase 1: 1997 to 2007) (Phase 2: 2004 to 2040) Preferred Alternative (See Page S-45)	Phase 1: • Construct two low-activity waste separations and immobilization demonstration facilities (one facility would include high-level waste vitrification). • Operate facilities for up to 10 years and treat up to approximately 76 million liters (20 million gallons) of the tank waste volume. • Store treated waste onsite pending development of an onsite disposal facility and availability of a potential geologic repository. Phase 2: • Upgrade and continue operation of demonstration facilities for an additional 10 years. • Construct one combined full-scale low-activity waste separations and immobilization facility and one high-level waste vitrification facility. • Retrieve all waste practicable (assumed to be 99 percent) from all single-shell and double-shell tanks. • Separate tank waste into high-level and low-activity waste streams (use sludge washing, caustic leaching, ion exchange, and other separations as required). • Store high-level waste onsite pending availability of a potential geologic repository. • Dispose of high-level waste offsite at a potential geologic repository. • Dispose of low-activity waste onsite in near-surface vaults.

Notes: [1] Impacts as shown in the EIS include a representative closure scenario (closure as landfill) to provide a meaningful comparison of alternatives. This closure scenario consists of placing an earthen barrier over the tanks and low-activity waste vaults.

[2] Time frames shown are through closure or following transport of high-level waste offsite, whichever is later and does not include post-closure monitoring.

S.5.2 Cesium and Strontium Capsule Alternatives

The cesium and strontium waste is classified as waste by-product and currently is stored in the Waste Encapsulation and Storage Facility. The alternatives addressed in the EIS for disposal of the cesium and strontium capsules include 1) no action; 2) onsite disposal in newly constructed shallow wells; 3) offsite disposal at a geologic repository by overpacking the capsules and shipping them to a repository; or 4) physically mixing the capsule contents with the high-level tank waste, which would be vitrified and disposed of at a potential geologic repository. All of the alternatives (Figure S.5.2) include continued monitoring and maintaining the integrity of the capsule and support facilities. These alternatives are described in Table S.5.2.

Figure S.5.2 Capsule Alternatives

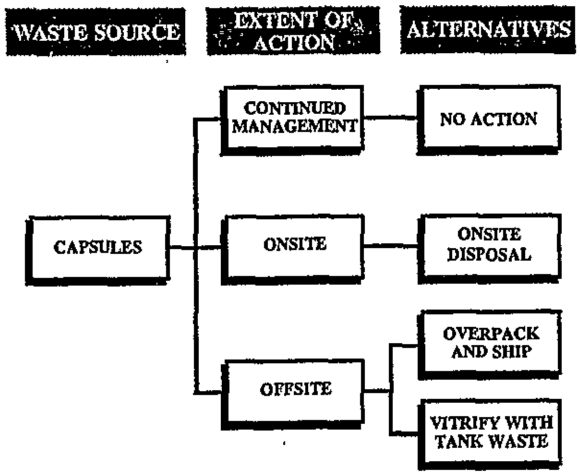


Table S.5.2 Summary of Capsule Alternatives

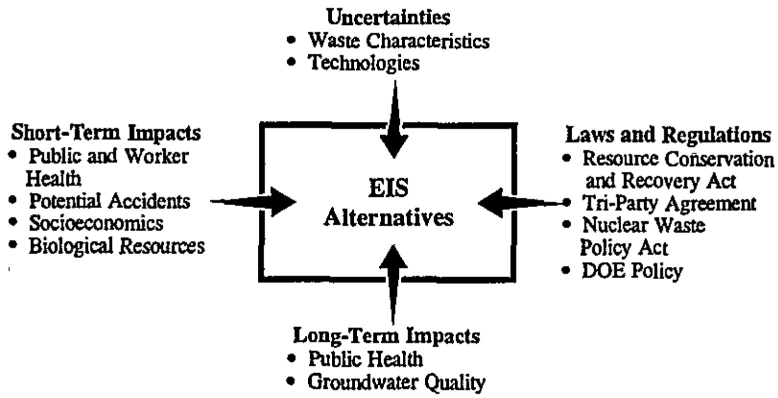
Alternative (Time Frame) [1]	Key Features
No Action (1997 to 2007)	• Continue existing operations and maintenance in the Hanford Site Waste Encapsulation and Storage Facility for 10 years, at which time DOE would revaluate storage and disposal alternatives.
Onsite Disposal (1997 to 2029)	• Place the cesium and strontium capsules in canisters. • Dispose of onsite in a newly constructed dry-well disposal facility.
Overpack and Ship (2003 to 2029)	• Place the cesium and strontium capsules in canisters. • Overpack canisters in larger canisters. • Ship and dispose of offsite at a potential geologic repository.
Vitrify with Tank Waste (1997 to 2029)	• Remove capsule contents. • Vitrify with the high-level tank waste. • Dispose of the immobilized waste offsite at a potential geologic repository.

Notes: [1] Time frames shown are through closure or following transport of high-level waste offsite, whichever is later and does not include post-closure monitoring.

S.6 ENVIRONMENTAL IMPACTS

The tank waste currently is stored in 177 underground tanks, and the cesium and strontium capsules are stored in the Waste Encapsulation and Storage Facility. The cost of continuing to store the waste is high, and the storage facilities are becoming less reliable with age. Some of the single-shell tanks have leaked contaminants into the surrounding soil and, on average, one additional tank begins to leak each year.

Figure S.6.1 Factors Influencing Evaluation of Alternatives



The Waste Encapsulation and Storage Facility is aging, and B Plant, which provides support facilities for the Waste Encapsulation and Storage Facility, is scheduled for demolition. In response to these conditions and the applicable regulations, DOE, Ecology, and EPA have entered into the Tri-Party Agreement, an enforceable strategy to dispose of the tank waste. DOE, Ecology, and EPA have developed an overall plan for remediation, which is identified in the Tri-Party Agreement. This plan and the full range of reasonable alternatives are analyzed in the EIS.

Each of the alternatives described in Section S.5 involves some trade-off among the 1) risk of failure of a component of the alternative due to technical uncertainties; 2) short-term human health and environmental impacts; 3) long-term human health and environmental impacts; and 4) compliance with laws, regulations, and policies (Figure S.6.1). An understanding of these factors is important to an understanding of the comparison of alternatives presented in Section S.7.

S.6.1 Uncertainty

Uncertainties associated with the characteristics of the tank waste and technologies involved in some alternatives add a degree of complexity to the calculation of environmental impacts.

The tank waste contains a complex mix of chemical and radiological constituents that is constantly changing as chemical reactions and radioactive decay occur. The contents of each tank are not well understood; however, there is a better understanding of the contents of the tank system as a whole. Considerable historical data on the tank contents are available and have been used to estimate the contents. These historical data provide a basis for an overall tank waste inventory and are compiled from invoices of chemical purchases and records of waste transfers and processing. Historical tank content estimates have been completed for the double-shell tanks and solid waste in the single-shell tanks.

There is an ongoing waste characterization program to better determine the contents of each tank through analyses of samples to help resolve safety issues and support design decisions for implementing the remediation alternative. However, this program will not be complete for many years. The lack of detailed characterization information on a tank-by-tank basis adds a level of uncertainty to many aspects of the tank waste remediation project.

In addition, certain technologies that may be used to remediate the waste have not been performed, have not been applied at the scale necessary for this project, or have not been previously applied to this type of waste. For example, there are uncertainties with the application of in situ vitrification on a scale necessary to remediate the tank waste and the effectiveness of certain high-level and low-level waste separations processes. The level of uncertainty involved with each alternative is described in Section S.7.0. Extensive research and some testing have been performed in recent years to reduce the level of uncertainty, but a level of uncertainty will remain until better performance data are available.

To account for these uncertainties, the analyses in the EIS are based on waste characterization, retrieval, and processing data and calculations that provide a conservative analysis of the impacts likely to occur and thus bound the impacts of the alternatives.

Health Effects Terms

Carcinogenic: An exposure to a radionuclide or nonradiological chemical that has been proven or suspected to be either a promoter or initiator of cancer in humans or animals.

Hazard Index: A measure of the noncarcinogenic health effects of human exposure to chemicals. Health effects are assumed to be additive for exposure to multiple chemicals. A hazard index of greater than 1.0 is indicative of potential adverse health effects. Health effects could be minor temporary effects or fatal, depending on the chemical and amount of exposure.

Incremental Lifetime Cancer Risk: A measure of the potential of developing cancer based on exposure to individuals from known or suspected radionuclides or carcinogenic chemicals. It reflects the level of risk of contracting cancer in terms of one individual's risk of contracting cancer among the entire exposed population (e.g., 1 in 10, 1 in 10,000, 1 in 1 million).

Latent Cancer Fatality: A fatality resulting from cancer caused from exposure to a known or suspected radionuclide or carcinogenic chemical.

Maximally-Exposed Individual: A hypothetical member of the public or worker who, by virtue of location or living habits, could receive the highest dose from an exposure to radionuclides or carcinogenic chemicals.

Population: For risk assessment purposes, population consists of the total potential members of the public or workforce who could be exposed to radiation or chemical dose from radionuclides or carcinogenic chemicals.

S.6.2 Short-Term Impacts

The primary short-term impacts are potential health effects, disturbance of shrub-steppe habitat, and socioeconomic impacts.

Short-Term Potential Health Effects

Potential health effects would result from 1) occupational accidents; 2) occupational radiological exposure during operations and waste transportation; 3) radiological and chemical accident; and 4) transportation accdients from deliveries of materials and supplies to the site.

Occupational accidents are injuries and fatalities to project workers, such as falls from ladders or twisted ankles, that occur at predictable rates. The number and severity of accidents are dependent on the type of activity and the number of labor hours spent performing the activities. Construction activities have the highest accident rates. Therefore, alternatives that would involve extensive construction labor hours would tend to have the highest number of occupational injuries and fatalities. The alternatives would begin in 1997 and end in approximately 2100, including the administrative control period.

All alternatives except the No Action alternative would involve extensive activities only during their construction and operations periods, which would be completed no later than 2040. The total labor years would be highest for the Long-Term Management alternative (108,000). For the alternatives that would remediate tank waste, total labor years would range from 26,100 for the In Situ Fill and Cap alternative to 87,300 for the Phased Implementation alternative. Each of the alternatives would result in an estimated one to three occupational fatalities during remediation.

> **Short-Term Impacts**
>
> Short-term impacts are those that would occur during remediation and during the post-remediation monitoring and maintenance activities, assumed to be 100 years for purposes of analysis.

Occupational radiological exposures are the routine exposures received from working in proximity to radioactive sources. They would occur while managing the tank farms, performing remedial activities, and during shipments of high-level waste to a potential geologic repository. Exposures are closely monitored, and the radiation dose a worker may receive is limited by law and Hanford Site administrative controls. Extensive historical data are available to calculate the doses radiological workers would receive, and there are standard methods for calculating the statistical probability of a person contracting cancer from a dose. Workers are informed of the potential risk before performing work and routinely informed of the doses they receive.

The alternatives with the largest workforce of radiological workers and the largest number of shipments of high-level waste to a potential geologic repository, such as the extensive retrieval alternatives, would tend to have the highest risk of latent cancer fatalities. Each of the alternatives except the No Action, Long-Term Management, and In Situ Fill and Cap alternatives may result in one to four latent cancer fatalities from occupational exposures. The ex situ alternatives would all involve offsite shipment of high-level waste, which may result in none to four fatalities from routine exposure during transportation to a potential geologic repository.

Radiological and chemical accidents are unexpected events that result in the release of radiological and chemical contaminants that may result in exposure to project workers, other nearby nonproject workers, or to the public if the release was large enough. The potential for radiological and chemical accidents would be analyzed extensively for each component of the design during the final design phase of the project. Engineering or administrative controls would be incorporated into the design and operating procedures to reduce the probability of serious accidents to an acceptable level. Even with these controls in place, accidents could occur, although the probability of occurrence would be extremely low. Radiological and chemical accidents and their potential consequences are specific to the types of activities being performed. They include accidents such as potential spray releases during the transfer of waste in the cross-site transfer line, breakdown in the air filtration system, or transportation accidents during offsite shipment of high-level waste to a geologic repository.

Because of the uncertainties involved with the tank waste characterization data and the conceptual nature of the designs, a bounding approach to estimating accident consequences was taken in the EIS. Conservative estimates were made for the type and amount of contaminants that would be released and how they could be transported in the atmosphere to expose workers and the public. Therefore, the health effects calculated provide an upper bound for the health effects that could occur. Potential health risks are calculated for the maximally-exposed individual and the population as a whole for both the workforce and the offsite public. The probability that the accident would result in a latent cancer fatality due to radiological or chemical exposure is calculated, as well as other potential health effects from exposure to chemicals. The potential health effects are multiplied by the calculated probability that the accident would occur to present a measure of the health risk to the project workers, nearby Site workers, and the public. From none to three fatalities may result from each of the alternatives (taking into account the probability of occurrence).

Transportation accidents are the injuries and fatalities resulting from both rail and truck accidents. The transportation scenarios analyzed include transportation of building and operating materials to support the alternatives. The incidence rates for injuries and fatalities were based on U.S. Department of Transportation statistics, Washington State highway accident reports, and Hanford Site statistics. The total number of transportation fatalities would be none to one fatalities for the No Action, Long-Term Management, and in situ alternatives and between three and six fatalities for all other alternatives.

Only the extensive retrieval alternatives would potentially involve accidents from the transportation of high-level waste to an offsite potential geologic repository; however, none of the alterantives would be expected to result in a latent cancer fatality due to radiological or chemical exposure.

Shrub-Steppe Habitat Disturbance
The extent of disturbance of shrub-steppe habitat is dependent on the size of surface disturbance for construction of facilities. In the 200 Areas, where most of the remediation activities addressed in this EIS would occur, most of the land has been disturbed previously by the construction of roads, processing facilities, pipelines, and other facilities associated with the production of plutonium and waste management. However, all of the alternatives except the No Action alternative would result in the disturbance of some shrub-steppe habitat. The amount of habitat lost would range from 10 to 41 hectares (25 to 100 acres) for the Long-Term Management and minimal retrieval alternatives to 72 to 100 hectares (180 to 250 acres) for the extensive retrieval alternatives. The sensitive wildlife species that inhabit this area also would be displaced. For all alternatives, the total disturbance of shrub-steppe habitat would be less than 1 percent of the shrub-steppe habitat on the Central Plateau. DOE would implement a mitigation plan to replace the loss of critical habitat to partially offset these impacts.

> **Calculating Habitat Impacts**
>
> For each alternative, a conservative estimate of potential habitat impacts was developed based on the total area required for new facilities and the extent of each proposed site that is previously disturbed versus undisturbed habitat. Habitat impacts then were calculated by assuming that the new facilities would result in habitat disturbances at the same ratio. During final design and siting of facilities, however, impacts could be reduced to below those identified in the EIS by siting more facilities on previously disturbed land.

Socioeconomic Impacts
The socioeconomic impacts would be an indirect result of the size of the workforce involved in remediation, which is dependent on the size and complexity of the facilities constructed and the length of time operated. The workforce required to implement each alternative at the Hanford Site would generate indirect impacts such as new jobs, population growth, and demands for public facilities and services (e.g., schools) in the Tri-Cities as well as traffic congestion and accidents, including fatalities. These impacts are dependent on the level of employment estimated for each alternative. Therefore, the alternatives that involve larger workforces, such as the extensive retrieval alternatives, would have the greatest level of socioeconomic impact. All of the alternatives except the No Action alternative would create new jobs at the Hanford Site. Peak year employment typically would occur during the construction phase for each alternative except No Action. The extensive retrieval alternatives would involve the highest levels of peak employment, ranging from 4,100 to 6,700 jobs.

New jobs created under each alternative would have impacts on the Tri-Cities economy based on the number of jobs created. These impacts would include indirect impacts including increased population, retail sales, housing prices, increased demands for housing and public facilities and services, traffic congestion, and traffic accidents. The level of impact is directly related to the level of jobs created. A large number of jobs would be created over a short period of time under the extensive retrieval alternatives, which would result in a boom-bust cycle that could adversely impact the Tri-Cities economy.

S.6.3 Long-Term Impacts

Potential long-term impacts were addressed in the Draft EIS to 10,000 years into the future. The primary long-term impacts would be groundwater contamination and the potential health effects associated with consumption of the groundwater, potential health effects resulting from post-remediation intruders and accidents, and restrictions on land use.

> **Long-Term Impacts**
>
> Long-term impacts are those that occur after the administrative control period, which is assumed to be 100 years. Potential impacts were addressed 10,000 years into the future.

Groundwater

Groundwater is the principal pathway for humans to be exposed to contaminants from the waste after remediation. Contaminants could reach the groundwater from releases during retrieval of the waste from the tanks, releases from residual materials left in the tanks after remediation, and releases from immobilized waste in the onsite low-activity waste vaults (Figure S.6.2).

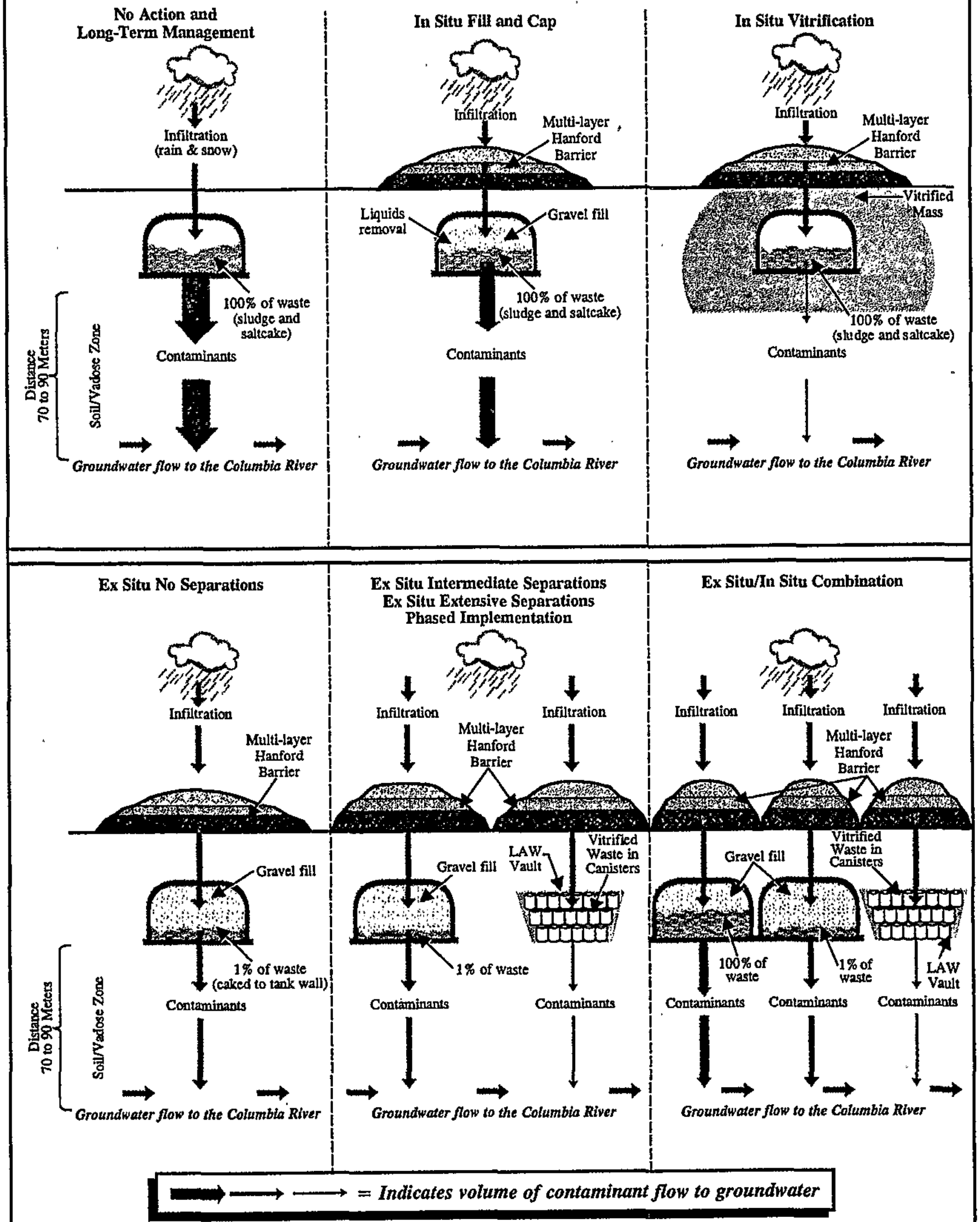
Liquids currently are leaking from some of the single-shell tanks because the tanks have corroded. The amount of liquids within the single-shell tanks currently are being reduced through pumping much of the liquids out of the tanks and transferring the liquids to the double-shell tanks, a process called saltwell pumping.

Liquids are expected to be released from the single-shell tanks during the implementation of any alternative that includes removing the waste from the tanks. These releases could occur because the principal retrieval method involves using large quantities of liquids to dissolve and suspend the solids in the tanks so they could be pumped to the surface for treatment, a process called sluicing. Measures would be incorporated to control the sluicing liquid as much as possible. No leaks would be expected during retrieval from the double-shell tanks because they have a second shell to contain any leaks.

Another method of retrieval involves the use of an articulated arm to reach into the tanks and recover waste. This process, which would be used to retrieve the waste that is the most difficult to recover, involves spraying liquid at high pressures in a localized area using less water and providing better liquid control than sluicing. This technology would reduce the amount of leakage.

Releases of contaminants also would occur after remediation as water from precipitation would slowly move through the earthen surface barriers placed over the tanks, dissolve contaminants from the residual waste left in the tanks, and slowly carry the contaminants through the soil and into the groundwater, which occurs at 70 to 90 meters (230 to 300 feet) below the tanks. This is a long-term process, and hundreds to thousands of years would be required to leach the contaminants into the groundwater depending on which alternative is selected. Some contaminants, such as technetium, would be leached more easily than others and would enter the groundwater more quickly than slower-moving contaminants such as cesium. The amount and rate at which contaminants would enter the groundwater is dependent on whether the contaminants had been processed into a more stable waste form, referred to as immobilization,

Figure S.6.2 Groundwater Pathways by Alternative



NOTE: Range in time of arrival in groundwater influenced by waste retrieval, treatment, and location.

and whether an earthen surface barrier had been placed over the waste. An immobilized waste form, such as a vitrified waste (waste turned into glass) would release contaminants at a very slow rate over a long period of time. An earthen surface barrier also would limit infiltration of precipitation into the waste, which would reduce the rate at which contaminants would reach groundwater.

All of the alternatives, except the No Action and Long-Term Management alternatives, would include an earthen surface barrier to isolate the waste that would remain in the tanks. All alternatives except the No Action, Long-Term Management, In Situ Fill and Cap, and the Ex Situ/In Situ Combination alternatives would involve immobilizing all of the waste that would remain onsite except the residual waste that cannot be recovered from the tanks.

Contaminants also would be leached from the near-surface low-activity waste disposal vaults by the same process described for the tank residuals. However, because many of the radionuclides would be removed from the waste during the separations process, and because the waste would be in an immobilized form, the rate of leaching of contaminants would be very slow, and therefore the amount of contaminants that would reach the groundwater would be small. The greater the level of separations performed and the greater the effectiveness of the immobilization process, the lower the level of contamination in the groundwater. The vaults also would be covered with an earthen surface barrier to inhibit infiltration of precipitation. In general, for the alternatives that would involve extensive retrieval, the amount of contamination in the groundwater from the immobilized waste in the near-surface low-activity waste disposal vaults would be up to 100 times less than the contamination that would result from leaks during retrieval and leaching of the residuals in the tanks.

Once contaminants reached the groundwater, they would move relatively quickly, and in approximately 25 years, would discharge into the Columbia River where they would be rapidly dispersed. The EIS analyzes all of these potential mechanisms for each alternative, analyzes potential exceedences of groundwater standards, and presents the potential human health impacts associated with consumption of the groundwater.

There is a substantial amount of uncertainty in estimating the levels of contaminants in the groundwater over the 10,000-year period of analysis. Changes in climate and land uses as well as the performance of the earthen surface barriers and the immobilization technologies could all affect the calculated levels of contamination and their distribution. Also, additional remediation could be determined to be necessary during closure, which would reduce the releases of contaminants into the groundwater. The groundwater impacts should be considered in the context of groundwater contamination from other Hanford Site activities, as discussed in Section S.3.

The No Action and Long-Term Management alternatives would result in by far the highest and fastest contamination of the groundwater because the waste would not be retrieved or immobilized, and an earthen barrier would not be placed over the tanks (Figure S.6.2). The contaminants would reach the groundwater in approximately 130 years and would reach maximum concentrations in approximately 210 years and then gradually decrease over several thousands of years.

The In Situ Fill and Cap and Ex Situ/In Situ Combination alternatives would result in the next highest levels of groundwater contamination because the solid waste would remain in some or all of the tanks, and the waste would not be immobilized. The contaminants would not reach the groundwater for approximately 2,300 years for the In Situ Fill and Cap alternative and approximately 1,100 years for the Ex Situ/In Situ Combination alternative. The earlier arrival of contaminants for the Ex Situ/In Situ Combination alternative is due to the releases assumed to occur during retrieval. Contaminants resulting from each of the alternatives would reach maximum concentrations in approximately 5,000 years and then decrease slowly over many thousands of years.

All of the extensive retrieval alternatives would have approximately the same maximum concentrations of contaminants because most of the contamination would come from releases during retrieval or from the tank residuals, which would be the same for all alternatives. This maximum concentration would be lower than any of the other alternatives except the In Situ Vitrification alternative. The contaminants would not reach the groundwater for approximately 1,000 years and would reach a maximum concentration in approximately 6,600 years. The contaminants then would decrease slowly over many thousands of years.

The In Situ Vitrification alternative would result in the lowest levels of contamination if the in situ vitrification technology functioned effectively. The contaminants would not reach the groundwater for approximately 2,400 years and would remain relatively constant for many thousands of years.

Potential Health Effects

The long-term health effects are dependent on the rate of release to the environment of any contaminants that would remain onsite, how the contaminants would be transported through the environment, and how humans and ecological resources would be exposed to the contaminants. The only anticipated post-remediation pathway would be through consumption of contaminants that may enter the groundwater as previously described.

Hypothetical Future Land Users

The **hypothetical residential farmer** is a farmer assumed to live on the Hanford Site (excluding the area over the tanks). The residential farmer engages in farming activities such as growing and consuming crops and livestock and using the groundwater for drinking, showering, and watering crops and animals.

The **hypothetical industrial worker** is an individual whose job at a site (not Hanford Site-related) is primarily indoors, but would include some outside activities. This individual's exposure pathways would include soil ingestion, dermal contact, fugitive dust, volatile inhalation, groundwater drinking, and showering. The individual is assumed to work 250 days per year at the job site.

The **hypothetical recreational user** is an individual who uses the Hanford Site and Columbia River for recreational activities such as hunting, fishing, boating, and swimming. This individual's exposure pathways would include dermal contact from soil, sediment, and surface water and ingestion of soil, surface water, and groundwater. The individual is assumed to spend 14 days per year participating in these recreational activities.

Because the groundwater discharges to the Columbia River within the Hanford Site, a person would need to be on the Site and consume groundwater or plants irrigated with groundwater, or be exposed to contaminants from the groundwater that would seep into the Columbia River along its banks within the Site boundary. Contaminants reaching the Columbia River would quickly disperse to extremely low levels as they entered the river and would present an extremely low potential health risk. Releases to the groundwater would occur over many thousands of years, so the potential human health risk also would occur over many thousands of years.

The EIS presents the risk to several different potential users of the land at various points in time to 10,000 years from the present and the total number of fatalities that could result over the 10,000-year period of analysis from the implementation of each alternative under one potential future use scenario. The potential post-remediation site users addressed in the EIS are a residential farmer, industrial worker, and recreational user of the Columbia River. Potential health impacts to users of the Columbia River downstream of the Hanford Site also are addressed.

The long-term risk of contracting cancer for the potential onsite farmer, industrial worker, and recreational user would be high for the No Action and Long-Term Management alternatives; up to a 1 in 2 chance for the onsite farmer, up to a 1 in 10 chance for the industrial worker, and a 1 in 100 chance for the recreational user. The risk would be less but still relatively high for the In Situ Fill and Cap and Ex Situ/In Situ Combination alternatives; up to a 1 in 100 chance for the onsite farmer, up to a 3 in 1,000 chance for the industrial worker, and up to a 2 in 10,000 chance for the recreational user. The risk for the extensive retrieval alternatives and the In Situ Vitrification alternative would be relatively low; up to a 3 in 10,000 chance for the onsite farmer, up to a 1 in 10,000 chance for the industrial worker, and a 2 in 1 million chance for the recreational user.

An assessment was prepared of the total latent cancer fatalities that could occur over 10,000 years for each of the exposure scenarios; residential farmer, industrial worker, and recreational shoreline user. The uncertainties associated with these calculations are high; however, they provide a way to understand and compare the relative risks to future populations. These calculations are based on assumptions and represent one of many possible scenarios representing long-term risk. If farming on the Hanford Site were to occur, the No Action and Long-Term Management alternatives may result in 600 fatalities over 10,000 years. The In Situ Fill and Cap and Ex Situ/In Situ Combination alternatives may result in 300 and 60 fatalities, respectively over 10,000 years. The other alternatives may result in 0 to 10 fatalities over 10,000 years. The industrial worker and recreational user scenarios would result in much fewer fatalities as shown in Table S.7.3.

The potential health risks to the users of the Columbia River also were calculated. The total number of fatalities over 10,000 years was calculated for an estimated population of 500,000 people. Uses of the Columbia River analyzed included fishing, boating, swimming, irrigating crops, and drinking water. The total number of fatalities calculated for the 10,000-year period was 2 fatalities for the No Action and Long-Term Management alternatives, 1 fatality for the In Situ Fill and Cap alternative, and 0 fatalities for all other alternatives.

These risks should be considered in the context of contamination from other Hanford Site activities. As discussed in Section S.3, the groundwater currently contains high levels of numerous contaminants, and there are additional contaminants within soil that would be transported slowly to the groundwater. The potential impacts from the Tank Waste Remediation System alternatives must be evaluated within the context of the current contamination and plans for remediation and long-term use of the Site. There are many uncertainties associated with calculating potential health risks to 10,000 years into the future. Changes in climate, land use, and many other factors could greatly influence these numbers.

Land Use

The contaminants in the tanks and groundwater would persist for many thousands of years, and the ability to ensure that administrative controls would be maintained over this length of time is not certain. Under all of the alternatives, some waste would be left onsite, which would preclude using a portion of the 200 Areas for any purpose except waste management and disposal for thousands of years. Permanent markers (stone monuments) would be placed around any waste left onsite to warn people of the hazards associated with disturbing the site. The 200 Areas of the Hanford Site have been identified as potential exclusive use areas for waste management activities, and DOE will maintain administrative controls of these areas for the foreseeable future.

> **100-Year Administrative Control Period**
>
> For purposes of analysis, it was assumed that DOE or some other Federal agency would retain administrative control of the Hanford Site for 100 years to control access to areas where humans may come in contact with contaminants and to perform monitoring and maintenance of remaining facilities.

The groundwater contamination that would result from each of the alternatives would occur under much of the Hanford Site north and southeast of the 200 Areas for many thousands of years. Use of the land surface over these areas would not present a human health risk from the Tank Waste Remediation System waste, but use of the groundwater from this area or use of the Columbia River shoreline would result in varying degrees of human health risk depending on which alternative is implemented. It is not certain that restrictions on groundwater use could be maintained over thousands of years, and it is assumed that people eventually would move onto the Hanford Site and use the contaminated groundwater for residential, industrial, and agricultural purposes. Therefore, the risk from consuming groundwater within the Site boundary would be expected to exist over a long period of time. This risk is different for each alternative depending on the factors discussed in the previous section.

Generally, a health risk greater than 1 chance in 10,000 of contracting cancer is considered high, and restrictions may be placed on areas that exceed this level. Based on this criteria, use of portions of the Hanford Site for farming and industrial purposes would need to be restricted for the No Action, Long-Term Management, In Situ Fill and Cap, and Ex Situ/In Situ Combination alternatives. Use of the Site for farming or industrial purposes would result in a risk near the 1 chance in 10,000 criteria for all other alternatives except for the In Situ Vitrification alternative, which would result in a risk of 1 chance in 100,000.

Use of the southern shoreline of the Columbia River would exceed the criteria of the 1 chance in 10,000 of contracting cancer for the No Action and Long-Term Management alternatives. The risk to the recreational user would be near the 1 chance in 10,000 criteria for the In Situ Fill and Cap alternative. None of the other alternatives would exceed this criteria for using the Columbia River shoreline. The maximum risk levels would occur within approximately 300 years for the No Action and Long-Term Management alternatives, but would not occur for approximately 5,000 years for the other alternatives.

Post-Remediation Intruders and Accidents
There are two ways that humans could be exposed to contaminants after the administrative control period other than consuming contaminants in the groundwater or being exposed to contaminants along the Columbia River shoreline. They include intruders into waste that remains onsite and accidents that could occur from natural causes if the waste was not disposed of securely and permanently.

Hypothetical Intruders

The **hypothetical driller** is an individual who works for a drilling company. This individual drills a 30-centimeter (12-inch)-diameter well through the tank waste. It is assumed that it takes 40 hours to complete the operation. The individual's exposure pathways include inhalation of contaminated dust while drilling through waste and external exposure to penetrating radiation from waste brought to the surface.

The **hypothetical post-drilling resident** is an adult who, as a result of drilling, is exposed to contaminated soil from within the waste that is brought to the surface and spread over 2,500 square meters (0.62 acre). This individual has three exposure pathways; exposure to airborne contamination via inhalation, external exposure to penetration radiation, and consumption of contaminated produce (25 percent of the individual's diet of fruit and vegetables).

Intruders are persons who ignore warning signs and permanent markers and go to great effort to gain access to the waste. The EIS analyzes the impacts that would occur from the most likely intruder scenario. This scenario is someone who drills a well into the waste remaining onsite after remediation and spreads the contaminants encountered during drilling on the ground surface. Potential health impacts were analyzed for the driller and a person who might use the contaminated Site as a residence after drilling the well.

The severity of the potential health impacts depends on the amount of waste brought to the surface and whether the waste has been immobilized. The potential risk for an intruder would be high for all of the alternatives with a range of 1 chance in 1 to 3 chances in 100 of contracting cancer. A 1 chance in 1 means there is a 100 percent probability of contracting cancer. The risk is highest (1 chance in 1) for the alternatives that involve leaving the waste in the tanks without immobilizing the waste.

Potential post-remediation accidents could occur from earthquakes or other natural events if sufficient measures are not taken to ensure the waste that remains onsite is permanently isolated and disposed of securely. The only natural event with a credible probability of impacting remediated waste within 10,000 years would be an earthquake. Seismic activity in the Hanford Site area is low compared to other regions of the Pacific Northwest, and there are few active faults on or near the Site. Regional seismic stresses are low and are estimated to result in a maximum of 0.06 millimeter/year (0.002 inch/year) structural displacement over the entire Columbia Plateau. Although rare and low in magnitude, earthquakes in the area will occur. For the No Action and Long-Term Management alternatives, the potential effects of an earthquake could be severe. The tank waste would not be stabilized under these alternatives, and the tank domes would lose their structural integrity over time and become less stable. At some point, which cannot be accurately calculated, the tank domes would collapse into the tanks. The initiating event could be an earthquake. If this were to occur, there would be an immediate release of relatively high levels of contaminants and continued releases at much lower levels until the waste was covered with earth by natural forces. The releases could be transported through the atmosphere, and the potential health effects to persons onsite and offsite could be catastrophic, with up to 200 fatalities from chemical or radiological exposures.

Another way that natural events could impact the waste after remediation would be from an explosion in the tanks. The tank waste currently generates flammable gases such as hydrogen. Although much of the gas is generated from a small number of tanks, nearly all of the tanks generate some flammable gas. Any waste left onsite that is not adequately immobilized would continue to release flammable gases after remediation. If these gases accumulate in sufficient quantities and in the necessary concentrations, they could be ignited by a natural event such as an earthquake. This could result in a fire or perhaps detonation within the tanks. The tanks would be covered with a minimum of 6.4 meters (21 feet) of earth (existing soil and the Hanford Barrier), so the most likely result would be a disruption or cracking of the Hanford Barrier, which potentially would increase the infiltration of precipitation and leaching of contaminants into the groundwater. The rate at which these gases are generated is decreasing and will continue to decrease over time, so the probability of this accident decreases with time. This potential post-remediation accident is more likely for the In Situ Fill and Cap alternative and the fill and cap portion of the Ex Situ/In Situ Combination alternative because large amounts of immobilized waste would be left in the tanks. This potential accident could be mitigated effectively by providing a mechanism for the gases to vent into the atmosphere. This is not a credible accident for the extensive retrieval alternatives.

S.6.4 Regulatory Compliance

Section S.4 summarizes the laws, regulations, and policies applicable to remediating the tank waste and cesium and strontium capsules. NEPA requires that EISs address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. A number of the alternatives addressed in the EIS would not be in compliance with the agreements contained in the Tri-Party Agreement, would not meet the land disposal restrictions under the Resource Conservation and Recovery Act and would not meet DOE policy for disposal of high-level waste. In addition, some of the alternatives that include disposing of high-level waste at a potential geologic repository may not meet the current planning basis for the repository or the volume limitations placed on the first repository by the Nuclear Waste Policy Act. If an alternative was selected that did not meet certain regulatory requirements, changes in policy, waivers of requirements from regulatory agencies, or changes in laws by Washington State or Congress would be necessary before that alternative could be implemented.

S.7 COMPARISON OF ALTERNATIVES

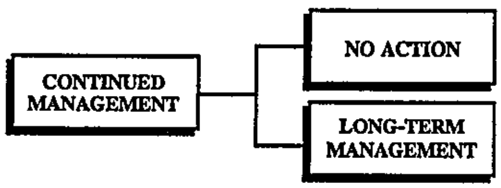
This section provides a comparison of the primary human health and environmental impacts associated with each of the alternatives.

S.7.1 Tank Waste Alternatives

All of the alternatives, except the Ex Situ No Separations alternative, would have similar short-term potential health effects including a calculated one to three occupational fatalities; none to one latent cancer fatalities from radiological and chemical operational accidents; none to six fatalities from transportation of materials and supplies to the project; latent cancer fatalities from accidents involving transportation of high-level waste to a potential geologic repository; none to four latent cancer fatalities from routine radiation exposures to workers during operations; and none to four latent cancer fatalities from routine exposures (principally workers) during shipments of high-level waste to a potential geologic repository.

Overall, the continued management and minimal retrieval alternatives would result in fewer health impacts during remediation than the extensive retrieval alternatives. The Ex Situ No Separations alternative would have a higher number of potential latent cancer fatalities from routine exposure during transportation of high-level waste to a potential geologic repository (two to four fatalities) due to a greater number of shipments that would occur and the waste form. The continued management alternative would have the highest groundwater quality impacts of any of the alternatives after the assumed loss of institutional control. Tables S.7.1 through S.7.6 provide an overall comparison of the tank waste alternatives.

Figure S.7.1
Continued Management Alternatives



Continued Management Alternatives

These alternatives would involve the continued management of tank waste and would not include remediation (Figure S.7.1). For the purpose of analysis, a 100-year period of continued management was assumed after which the tanks would be abandoned. Continuing to manage the tank waste instead of remediating the waste would result in fewer short-term impacts but greater long-term impacts.

Table S.7.1 Potential Short-Term Health Effects [1]

Alternatives	Potential Fatalities from Accidents During Remediation				Potential Fatalities from Radiation Exposure During Normal Remediation	
	Occupational [2] Accidents	Operational [3] Accidents	Transportation [4] Accidents	High-Level Waste Transportation [5] Accidents	Operational [6] Exposures	Transportation [7] Exposures
No Action	3	0	0	0	0	0
Long-Term Management	3	1	1	0	0	0
In Situ Fill and Cap	1	0	0	0	0	0
In Situ Vitrification	2	0	1	0	1	0
Ex Situ Intermediate Separations	3	1	5	0	4	2
Ex Situ No Separations:						
Vitrification	2	1	5	0	2	4
Calcination	2	1	3	0	2	2
Ex Situ Extensive Separations	3	1	6	0	3	0
Ex Situ/In Situ Combination	2	1	3	0	2	1
Phased Implementation	3	1	4	0	4	2

Notes: [1] Numbers rounded to nearest whole number.

[2] Occupational accident fatalities refer to nonradiological and nonhazardous chemical accidents from construction and operations such as falls from buildings.

[3] Operational accident fatalities refer to latent cancer fatalities resulting from the activities that involve radiological and chemical accidents and include the probability of occurrence. The number of potential fatalities that may occur if the bounding accident occurred would range from 2 to 52. However, because the probability of occurrence would be very low, when the probability of occurrence is multiplied by the potential number of fatalities, the result is a very low number of estimated fatalities.

[4] Transportation accidents refer to fatalities from physical trauma during deliveries of supplies and materials to the Site and nonradiological/nontoxicological accidents during transportation of high-level waste to an offsite geologic repository.

[5] Transportation accident fatalities refer to latent cancer fatalities resulting from high-level waste shipping accidents in an urban area and include probability of occurrence. The number of potential fatalities that may occur if the accident occured in an urban area would range from 0 to 8. However, because the probability of occurrence would be very low, when the probability of occurrence is multiplied by the potential number of fatalities, the result is a very low number of estimated fatalities and is 0 when rounded to the nearest whole number.

[6] Operational radiation fatalities result from radiation exposure during normal operations to workers and are expressed as latent cancer fatalities.

[7] Transportation fatalities result from radiation exposures to workers and the public involved in transporting high-level waste to a potential geological repository and are expressed as latent cancer fatalities.

Table S.7.2 Potential Short-Term Environmental Effects

Alternatives	Acres of Shrub-Steppe Habitat Disturbed	Additional Employment (Peak Employment) [1]
No Action	0	0
Long-Term Management	25	1,000
In Situ Fill and Cap	57	150
In Situ Vitrification	100	1,600
Ex Situ Intermediate Separations	210	4,100
Ex Situ No Separations:		
Vitrification	250	4,400
Calcination	200	4,400
Ex Situ Extensive Separations	180	6,700
Ex Situ/In Situ Combination	180	2,500
Phased Implementation	250	4,700

Notes: [1] Peak employment would occur during the construction phase of the project and would result in indirect adverse impacts such as increased housing prices, demands on public services, traffic congestion, and accidents. The higher numbers of peak employment would generate a boom-bust cycle within the Tri-Cities economy.

The current tank waste storage practices do not meet hazardous waste storage regulations, and continued storage would not comply with these regulations. Leaks from the tanks are occurring and would continue to occur. The estimated short-term cost would be low compared to all other alternatives, up to $230 million per year on an annualized average basis.

Continued management would allow time for development of additional waste treatment technology, if determined to be needed. After the 100-year duration of these alternatives, DOE still would need to determine how to remediate the waste, and the environmental impacts and cost associated with future remediation would be incurred at a later time.

If DOE did not remediate the tank waste, the long-term impacts would involve the addition of contamination to the groundwater in concentrations that would greatly exceed drinking water standards within 300 years, resulting in high potential health effects (potential latent cancer fatalities) to future users of the Site. Eventually, the tank domes would collapse causing high levels of contaminant releases and severe potential health impacts.

No Action Alternative

This alternative would include continuing the current tank waste management practices. No new actions would be taken to prevent additional leaking of liquids from the tanks or to improve the regulatory compliance status of the waste management activities. No waste remediation would be performed under this alternative.

This alternative would result in few short-term impacts, but the long-term impacts on the public health and environment would be severe. The groundwater within the Hanford Site would contain concentrations of contaminants thousands of times the drinking water standard.

Table S.7.3 Potential Long-Term Health Effects [1]

Alternatives	Health Risk Onsite Farmer		Health Risk Industrial Worker		Health Risk Shoreline Recreational User [2]		Downriver Users [4]
	Maximum Risk [2]	10,000-Year Exposure Scenario [3] (Fatalities)	Maximum Risk [2]	10,000-Year Exposure Scenario [3] (Fatalities)	Maximum Risk [2]	10,000-Year Exposure Scenario [3] (Fatalities)	10,000-Year Fatality Scenario [3]
No Action	1 in 2	600	1 in 10	200	1 in 100	50	2
Long-Term Management	1 in 3	600	1 in 10	200	1 in 100	50	2
In Situ Fill and Cap	1 in 100	300	3 in 1,000	200	2 in 10,000	20	1
In Situ Vitrification	1 in 100,000	0	<1 in 1 million	0	<1 in 1 million	0	0
Ex Situ Intermediate Separations	3 in 10,000	10	1 in 10,000	5	2 in 1 million	0	0
Ex Situ No Separations:							
Vitrification	3 in 10,000	10	1 in 10,000	5	2 in 1 million	0	0
Calcination	3 in 10,000	10	1 in 10,000	5	2 in 1 million	0	0
Ex Situ Extensive Separations	3 in 10,000	10	1 in 10,000	5	2 in 1 million	0	0
Ex Situ/ In Situ Combination	3 in 1,000	60	1 in 1,000	30	1 in 100,000	0	0
Phased Implementation	3 in 10,000	10	1 in 10,000	5	2 in 1 million	0	0

Notes: [1] Numbers rounded to the nearest whole number.
[2] Risk refers to the maximum incremental lifetime cancer risk, which is the chance that an individual may contract a cancer from radiological or chemical exposures.
[3] These numbers represent a calculation of potential latent cancer fatalities that could occur over 10,000 years after remediation under one possible land-use scenario and help to compare the relative differences among the alternatives.
[4] Total latent cancer fatalities over 10,000 years to the 500,000 people assumed to use the Columbia River downriver from the Hanford Site annually.

Table S.7.4 Intruder and Post-Remediation Accident Health Effects [1]

Alternatives	Waste Site Intruder Risk [2]	Total Fatalities for Post-Remediation Accident
No Action	1 in 1	Up to 200
Long-Term Management	1 in 1	Up to 200
In Situ Fill and Cap	1 in 1	0
In Situ Vitrification	1 in 10	0
Ex Situ Intermediate Separations	3 in 100	0
Ex Situ No Separations: Vitrification Calcination	3 in 100 3 in 100	0
Ex Situ Extensive Separations	3 in 100	0
Ex Situ/In Situ Combination	1 in 2	0
Phased Implementation	3 in 100	0

Notes: [1] Numbers rounded to the nearest whole number.
[2] Risk refers to latent cancer fatalities from radiological or chemical exposures.

The No Action alternative would result in high long-term risk to potential future users of the Site. The maximum risk of contracting cancer would be 1 in 2 for an onsite farmer, 1 in 10 for an industrial worker, and 1 in 100 for a recreational user of the Columbia River. These high risk levels would occur within 300 years and decrease slowly over many thousands of years. High levels of groundwater contamination would continue for hundreds of years.

The tank domes would lose their structural integrity and eventually fail. If they all were to fail at the same time in response to a natural event such as an earthquake, up to 200 fatalities could occur from radiological and chemical exposures.

Implementation of this alternative would not enable DOE to comply with the waste management and land disposal restrictions of the State Dangerous Waste Regulations (including the Resource Conservation and Recovery Act requirements), and DOE's policy for disposal of readily retrievable high-level waste, and would be inconsistent with the planned disposal of other high-level waste in a geologic repository. Implementation of this alternative also may require changes in the requirements for the disposal of high-level radioactive waste. This alternative would cost an estimated $13 to 16 billion over a period of 100 years.

Long-Term Management Alternative

This alternative is identical to the No Action alternative, except that two activities would be performed to improve the regulatory compliance status of the waste storage; upgrading the intra- and inter-tank farm waste transfer system, and replacing double-shell tanks twice during the assumed 100-year duration of the administrative control period to prevent the release of large volumes of liquid to the environment from the double-shell tanks. No waste remediation would be performed under this alternative.

Table S.7.5 Potential Long-Term Environmental Effects

Alternatives	Long-Term Groundwater Impacts	Potential Use Restrictions [1]
No Action	High	Use of Site groundwater Use of river shoreline
Long-Term Management	High	Use of Site groundwater Use of river shoreline
In Situ Fill and Cap	Moderate	Use of Site groundwater Use of river shoreline
In Situ Vitrification	Low	No restrictions
Ex Situ Intermediate Separations	Low	No restrictions
Ex Situ No Separations:		
Vitrification	Low	No restrictions
Calcination	Low	No restrictions
Ex Situ Extensive Separations	Low	No restrictions
Ex Situ/In Situ Combination	Moderate	Use of Site groundwater
Phased Implementation	Low	No restrictions

Notes: [1] Potential restrictions are based on levels of contamination from TWRS waste. Additional restrictions may be necessary due to other Site conditions.

Similar to the No Action alternative, this alternative would result in few short-term impacts, but the long-term impacts on public health and the environment would be severe. The Long-Term Management alternative would result in high long-term risk to potential future users of the Site. The maximum risk of contracting cancer would be 1 in 3 for an onsite farmer, 1 in 10 for an industrial worker, and 1 in 100 for a recreational user of the Columbia River. These high risk levels would occur within 300 years and decrease slowly over many thousands of years. The impacts on groundwater and associated potential health effects would be nearly identical to the No Action alternative. The tank domes eventually would fail, and up to 200 fatalities would occur from radiological and chemical exposures.

This alternative would result in improved compliance with the near-term waste management requirements of the State Dangerous Waste Act (including the Resource Conservation and Recovery Act requirements) but, in the long term, implementation of this alternative would not enable DOE to comply with the land disposal restrictions of the State Dangerous Waste Regulations (including the Resource Conservation and Recovery Act requirements), and DOE's policy for disposal of readily retrievable high-level waste, and would be inconsistent with the planned disposal of other high-level waste in a geologic repository. Implementation of this alternative also may require changes in the requirements for the land disposal of high-level radioactive waste. This alternative would cost an estimated $19 to 23 billion over a period of 100 years.

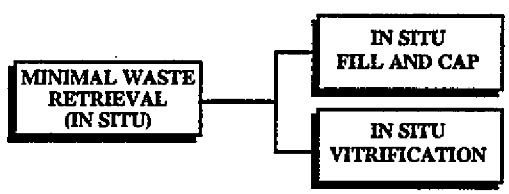
Table S.7.6 Regulatory Compliance, Technical Uncertainties, and Cost

Alternatives	Meets Waste Disposal Laws, Regulations, and Policy [1]	Degree of Technical Uncertainty [2]	Cost Range (Billions of Dollars) [3]
No Action	No	Low	13 to 16
Long-Term Management	No	Low	19 to 23
In Situ Fill and Cap	No	Low	7 to 9
In Situ Vitrification	No	High	16 to 24
Ex Situ Intermediate Separations	Yes	Moderate	30 to 41
Ex Situ No Separations:			
Vitrification	Yes	Moderate	69 to 253
Calcination	No	Moderate	39 to 86
Ex Situ Extensive Separations	Yes	Moderate	27 to 36
Ex Situ/In Situ Combination	No	Moderate	23 to 28
Phased Implementation	Yes	Low	32 to 42

Notes: [1] No means the alternative does not meet all applicable laws, regulations, and policies. A change in policy, waiver from a regulation, and/or a change in Federal or State law would be required to implement this alternative.
[2] A measure of the uncertainty involved with effectively implementing the technology included in the alternative. High uncertainty means the risk of failure is high.
[3] Cost ranges are provided to reflect the uncertainties with the conceptual nature of the designs and technologies involved. The relatively large range in costs for the Ex Situ Intermediate Separations, Ex Situ No Separations, and Phased Implementation alternatives is primarily a result of the assumptions made for repository fees at an offsite geologic repository for the high-level waste. The higher numbers reflect the current repository fee calculation method. The lower cost reflects an assumption that larger canister sizes would be accepted by the geologic repository.

Under the minimal retrieval alternatives, only liquid waste would be retrieved from the tanks (Figure S.7.2). The liquid waste would be concentrated in an evaporator and the solids returned to double-shell tanks. All solid waste and liquid waste that could not be readily retrieved would be disposed of in situ in the tanks. The issues associated with the minimal retrieval alternatives are 1) their ability to adequately protect the groundwater; 2) their ability to comply with Federal and State laws and regulations concerning the disposal of high-level waste and hazardous waste; and 3) uncertainties regarding the effectiveness of the technologies.

Figure S.7.2 Minimal Waste Retrieval (In Situ) Alternatives



In general, the short-term and long-term impacts of the minimal retrieval alternatives would fall between those of the continued management alternatives and the extensive retrieval alternatives. The primary exception is the impact on groundwater, which differs greatly between the two minimal retrieval alternatives. Based on the generic closure method assumed (placement of earthen surface barriers), the analysis indicates that the groundwater becomes more contaminated for the In Situ Fill and Cap alternative than for the In Situ Vitrification alternative. Final closure action to be addressed in a future closure plan could result in additional action to protect the groundwater.

<u>In Situ Fill and Cap Alternative</u>
This alternative includes removing the readily retrievable liquids from the tanks, filling the tanks with gravel, and placing an earthen barrier over the tanks. This alternative would involve few short-term impacts other than the relatively low level of fatalities from accidents and routine radiological exposures described previously. The long-term release of contaminants to the groundwater would be substantially lower than the continued management alternatives but relatively high compared to the other alternatives. Contaminants would not reach the groundwater for approximately 2,300 years and would increase in concentration until approximately 5,000 years in the future, after which time they would slowly decrease. The In Situ Fill and Cap alternative would result in relatively high long-term risk to potential future users of the Site. The maximum risk of contracting cancer would be 1 in 100 for an onsite farmer, 3 in 1,000 for an industrial worker, and 2 in 10,000 for a recreational user of the Columbia River. These relatively high risks would not occur until approximately 5,000 years in the future and would decrease slowly over many thousands of years.

Implementation of this alternative would not enable DOE to comply with land disposal restrictions of the State Dangerous Waste Regulations (including the requirements of the Resource Conservation and Recovery Act requirements), and DOE's policy for disposal of readily retrievable high-level waste, and would be inconsistent with the planned disposal of other high-level waste in a geologic repository. Implementation of this alternative also may require changes in the requirements for licensing for the land disposal of high-level radioactive waste.

This alternative involves the application of common technology, which has a high probability of working effectively for most tanks. This alternative may not be appropriate for those tanks that generate high levels of flammable gases because of the potential for sparks causing a fire in the tanks while filling with gravel. This uncertainty may apply to approximately 25 tanks. It is uncertain whether mitigation measures could be developed to prevent these fires. This alternative would involve the least estimated cost of any alternative, $7 to 9 billion.

<u>In Situ Vitrification Alternative</u>
This alternative involves removing the readily retrievable liquids from the tanks and vitrifying (melting and forming a glass) the waste in-place in the tanks. The In Situ Vitrification alternative would involve few short-term impacts other than the disturbance of 41 hectares (100 acres) of shrub-steppe habitat and the relatively low level of fatalities from accidents and routine radiological exposures described previously.

The long-term release of contaminants would not reach the groundwater for approximately 2,300 years, and the concentrations would be low. The In Situ Vitrification alternative would result in relatively low long-term risk to potential future users of the Site. The maximum risk of contracting cancer would be 1 in 100,000 for an onsite farmer, less than 1 in 1 million for an industrial worker, and less than 1 in 1 million for a recreational user of the Columbia River.

A major issue associated with this alternative is the effectiveness of the in situ vitrification process. In situ vitrification has been performed on contaminated soil to a maximum depth of 9 meters (30 feet), but has not been used on the tank waste or at the scale needed to vitrify the large (up to 18 meter [60 foot]-deep) tanks. In addition, it would be difficult to verify the effectiveness of this process because the waste least likely to achieve the necessary glass composition would be at the bottom of the tank.

Implementation of this alternative would not enable DOE to comply with DOE's policy for disposal of readily retrievable high-level waste and would be inconsistent with the planned disposal of other high-level waste in a geologic repository. Implementation of this alternative would also may require changes in the requirements for licensing for the disposal of high-level radioactive waste. This alternative would cost an estimated $16 to 24 billion.

Partial Retrieval

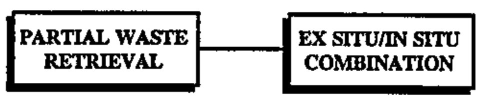
Ex Situ/In Situ Combination Alternative

The partial retrieval alternative, Ex Situ/In Situ Combination, was developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation (Figure S.7.3).

Because the contents of each tank differ greatly in physical, chemical, and radiological characteristics, it may be appropriate to implement different alternatives for different tanks. There is a wide variety of potential combinations of alternatives that could be developed and a number of criteria that could be used to select a combination of alternatives for implementation. The Ex Situ/In Situ Combination alternative was developed to bound the impacts that could result from a combination of alternatives, and it is intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste.

This alternative is a hybrid alternative that combines some of the advantages of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives into one alternative. Approximately half of the tank waste would be remediated in the same manner as in the In Situ Fill and Cap alternative, and the other half of the tank waste (that which contains the greatest amount of the contaminants that are readily transported in the groundwater and present the greatest human health risk) would be remediated in the same manner as in the Ex Situ Intermediate Separations alternative.

Figure S.7.3 Partial Waste Retrieval Alternative

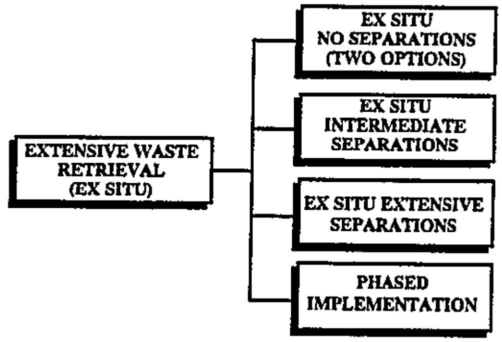


The short-term impacts would be lower and long-term impacts would be greater than the impacts of the In Situ Fill and Cap alternative. The Ex Situ/In Situ Combination alternative would result in relatively high long-term risk to potential future users of the Site. The maximum risk of contracting cancer would be 3 in 1,000 for an onsite farmer, 1 in 1,000 for an industrial worker, and 1 in 100,000 for a recreational user of the Columbia River. These relatively high risks would not occur for approximately 5,000 years from the present and then would decrease slowly over many thousands of years.

Implementation of this alternative would not enable DOE to comply with the land disposal restrictions of the State Dangerous Waste Regulations (including the Resource Conservation and Recovery Act), and DOE's policy for disposal of readily retrievable high-level waste, and would be inconsistent with the planned disposal of other high-level waste in a geologic repository. This alternative also would be inconsistent with the national policy to dispose of high-level waste in a geologic repository. Implementation of this alternative also would require changes in the requirements for licensing for the disposal of high-level radioactive waste.

There are no major technical uncertainties with the fill and cap portion of this alternative, but the same technical uncertainties exist for the ex situ intermediate separations portion of the alternative as exist for the Ex Situ Intermediate Separations alternative. This alternative would cost an estimated $23 to 28 billion.

Figure S.7.4 Extensive Waste Retrieval (Ex Situ) Alternatives



Extensive Retrieval Alternatives

Overall, the extensive retrieval alternatives would result in higher short-term impacts than the other alternatives but would provide substantially greater protection of the groundwater and therefore, substantially fewer health risks to potential future onsite farmers, recreational users of the Columbia River, and persons who may intrude into the residual waste in the tanks or low-activity waste vaults (Figure S.7.4). The extensive retrieval alternatives would involve 72 to 100 hectares (180 to 250 acres) of disturbance of shrub-steppe habitat, although this impact would be mitigated partially by a habitat replacement program. The extensive retrieval alternatives would involve the greatest levels of new employment (4,100 to 6,700 employees) during construction of facilities. These numbers of employees would cause indirect impacts such as a boom-bust cycle in the Tri-Cities, increased traffic congestion and traffic accidents, as well as strain on some social services (e.g., school and fire services).

The extensive retrieval alternatives would involve relatively low long-term risks to potential future users of the Site. The maximum risk of contracting cancer would be up to a 3 in 10,000 chance for an onsite farmer, a 1 in 10,000 chance for an industrial user, and a 2 in 1 million chance for a recreational user of the Columbia River.

The ex situ alternatives would result in the disposal of two types of waste on the Hanford Site; low-activity waste and residuals in the tanks. The low-activity waste from processing the high-level waste would be disposed of in vaults and would meet all groundwater protection requirements. The residual waste remaining in the tanks is part of closure of the tank waste, which will be addressed at a later time when sufficient information is available to assess the environment impacts. However, for purposes of comparing alternatives, it was assumed that the tank residual waste would be disposed of in the tanks with a generic closure scenario; closure as a landfill. Using this closure scenario, the calculations show exceedences of the water quality protection requirements for the tank residuals. The specific closure plan for the tanks would be developed in the future following consultation with the regulators. Therefore, theability to finally close the tanks in compliance with water quality protection requirements is dependent on the final closure plan to be developed.

The Nuclear Waste Policy Act, as amended, establishes the planning basis for the development of geologic repositories for disposal of high-level waste and commercial spent nuclear fuel. One of the requirements of the Nuclear Waste Policy Act is that the first geologic repository shall not accept in excess of 70,000 metric tons (77,000 tons) uranium or equivalent in the first repository prior to operation of a second repository. Within this capacity, 10 percent, or 7,000 metric tons (7,700 tons) heavy metal, has been set aside for disposal of DOE-owned spent nuclear fuel and high-level waste. How DOE intends to allocate the 7,000 metric tons (7,700 tons) heavy metal capacity has not been decided (i.e., spent nuclear fuel first with the balance from high-level waste; Savannah River waste before Hanford Site waste). Regardless of this allocation, there may be insufficient capacity in the first repository to accept all Hanford high-level waste under every alternative except for the Ex Situ Extensive Separations alternative. Some of the waste may need to be disposed of at a second geologic repository, or changes in the planning basis for the repository would be required to allow larger size canisters to be placed in the repository.

All of the extensive retrieval alternatives except for the Phased Implementation alternative involve a moderate level of technical uncertainty that the alternative could be implemented effectively. The uncertainties include 1) the effectiveness of the waste retrieval system and how much liquid may leak from the tanks during retrieval; 2) how effectively waste from multiple tanks can be blended to meet final waste specifications; and 3) the effectiveness of the processes for separating the waste into low-activity waste and high-level waste.

All of the extensive retrieval alternatives could be implemented with no changes to existing laws, regulations, and policies except for the calcination option of the Ex Situ No Separations alternative, which would not comply with the treatment requirements of the State Dangerous Waste Regulations (including the Resource Conservation and Recovery Act).

Ex Situ No Separations Alternative

This alternative would include vitrifying (melting the waste to form glass) or calcining (heating to temperatures below the melting point to form powder) all of the waste and shipping it to a potential geologic repository for disposal. This alternative would meet all regulatory requirements and would result in disposal of up to 99 percent of the waste offsite at a potential geologic repository.

However, neither the vitrified waste form (soda-lime glass) nor the calcined waste form (compacted powder) would meet the current waste acceptance criteria for a geologic repository because the current waste acceptance criteria requires borosilicate glass, a more stable waste form than soda-lime glass or compacted powder. In addition, whether the waste is calcined or vitrified, the amount of waste generated would exceed the capacity allotted in the first potential geologic repository.

As previously discussed, there are technical uncertainties associated with the extensive retrieval alternatives; however, because this alternative does not involve separations, the technical uncertainties are fewer than those associated with the other extensive retrieval alternatives.

This alternative would cost an estimated $69 to 253 billion. The Ex Situ No Separations (Vitrification) alternative has the largest estimated cost range due to the operating and disposal cost dependence on the number of high-level waste packages produced. Common assumptions for waste loading, blending, and canister size established for all vitrification alternatives resulted in 587,000 canisters (147,000 waste packages) for this alternative, which resulted in the upper-end cost estimate shown. Optimization of the waste package size and blending strategy could reduce the number of waste packages to approximately 21,400. This lower number of high-level waste packages would result in the lower-end cost estimate shown. The waste package would consist of a Hanford Multi-Purpose Canister with either 4 small (0.62 cubic meter [22 cubic feet]) canisters or 1 large (10 cubic meters [360 cubic feet]) canister suitable for disposal at a potential geologic repository. Changes in the planning basis for the geologic repository would be necessary to implement this alternative.

Ex Situ Intermediate Separations Alternative

This alternative would include performing the extent of separations necessary for the low-activity waste to meet drinking water standards. This would require enhanced sludge washing and cesium ion exchange separations processes.

This alternative would meet all regulatory requirements and involve a moderate level of technical uncertainty as discussed under the extensive separations alternatives, with an added degree of uncertainty due to the unproven nature of the separations process. The separations process would be far less complicated than for the Ex Situ Extensive Separations alternative. This alternative would cost an estimated $30 to 41 billion.

Ex Situ Extensive Separations Alternative
This alternative would include performing extensive physical and chemical separations to create the smallest volume and highest concentration of waste for offsite disposal at a potential geologic repository and the lowest concentration of low-activity waste for onsite disposal. This would require many different waste separations processes to achieve a high degree of separations. This alternative would meet all regulatory requirements.

This alternative would involve all of the technical uncertainties presented previously, and the additional uncertainties involved with the numerous and complex separations processes. This alternative would cost an estimated $27 to 36 billion.

Phased Implementation Alternative (Preferred Alternative)
This alternative is similar to the Ex Situ Intermediate Separations alternative, except that a greater extent of separations would be performed, and the alternative would be implemented in two distinct phases. The additional separations would include removal of technetium, strontium, and transuranic elements to reduce releases to the groundwater from the low-activity waste vaults and ensure that drinking water standards would be met.

This alternative would meet all regulatory requirements.

A key aspect of this alternative is that it would be implemented in two phases, starting with a demonstration-scale facility, to reduce the financial risk associated with the technical uncertainties of the ex situ technologies. This phased approach also would allow DOE to use the lessons learned from the demonstration phase to improve the design, construction, and operations of the full-scale facilities constructed during Phase 2. This phased approach would reduce the financial risk of building large facilities before the processes are proven to be effective and could lead to more efficient and effective operations during Phase 2. This alternative would cost an estimated $32 to 42 billion.

Basis for Identification of the Preferred Alternative
DOE and Ecology have identified the Phased Implementation alternative as the preferred alternative for the tank waste because it would provide a balance among key factors that influence the evaluation of the alternative; short-term impacts to human health and the environment, long-term impacts to human health and the environment, managing the uncertainties associated with the waste characteristics and treatment technologies, and compliance with laws, regulations, and policies.

The Phased Implementation alternative would permanently isolate the waste from humans and the environment to the greatest extent practicable and provide for protection of public health and the environment. A high percentage of the long-lived radionuclides would be disposed of offsite in a geologic repository. Releases of contaminants to the groundwater at the Hanford Site would be reduced to the greatest extent practicable. The waste disposed of onsite would be isolated from humans and the environment by immobilizing the low-activity waste and placing it in concrete disposal vaults covered with an earthen surface barrier to inhibit contaminants from reaching the groundwater, intrusion from plants and animals, and inadvertent intrusion by humans. Residuals left in the tanks would be reduced to the maximum extent practicable.

The Phased Implementation alternative also would allow DOE to obtain information concerning the uncertainties associated with waste characteristics and the effectiveness of the retrieval, separations, and vitrification technologies prior to constructing and operating full-scale facilities. This phased approach provides for the construction and operation of demonstration-scale facilities to obtain the needed process information before committing large capital expenditures for the full-scale facilities. Lessons learned from the demonstration phase would be applied to the full-scale phase, which may substantially improve the efficiency of operations of the second phase and reduce construction and operating costs.

As under all other alternatives, DOE would continue its policy of continually evaluating the issues associated with the Tank Waste Remediation System and its path forward as additional tank characterization data and process knowledge are obtained.

S.7.2 Cesium and Strontium Capsule Alternatives

None of the cesium and strontium capsule alternatives would result in substantial short- or long-term impacts to human health and the environment under nonaccident conditions. None of the alternatives would result in occupational fatalities or increased incidences of cancer or fatal chemical exposures. There would be low or no adverse impacts on surface water or groundwater, soil, air quality, transportation networks, noise levels, visual resources, biological resources, socioeconomic conditions, resource availability, or land use. There would be slight impacts on shrub-steppe habitat resulting in the loss of up to 1.8 hectares (4.5 acres) of habitat or less.

The only substantive environmental impacts associated with the cesium and strontium capsule alternatives would result from a major accident. If an earthquake were to occur with sufficient magnitude to collapse the aging Waste Encapsulation and Storage Facility, a calculated 10 worker fatalities may occur from falling debris and/or radiation exposure. An earthquake of this magnitude is calculated to occur approximately once every 4,000 years. Cleanup of the resulting contamination would be costly and hazardous to workers.

Accelerating the schedule for the alternatives would result in substantial cost savings because approximately one-half of the cost incurred for each alternative (except the No Action alternative) is continued storage.

No Action Alternative (Capsules)
The No Action alternative would maintain the availability of the capsules for future productive uses, if such uses can be developed. This alternative would not result in disposal of the capsules, so the cost and impacts of disposal would be delayed until some time in the future, if appropriate uses for the capsules are not developed. This alternative would have the least estimated cost of the alternatives ($112 million) during the assumed 10-year duration of continued storage.

Onsite Disposal Alternative
Because a potential geologic repository for high level-waste may not be available until after the year 2015, onsite disposal is the only alternative that would allow near-term disposal of the cesium and strontium capsules. This disposal would be in onsite shallow subsurface dry-wells, which would not meet the requirements of the Resource Conservation and Recovery Act for hazardous waste or DOE policy for disposal of readily retrievable high-level waste. Nearly all of the cesium and strontium would decay to nonradioactive chemicals and would result in essentially no impacts on groundwater. This alternative would have the highest estimated cost ($697 million) of all capsule alternatives.

Overpack and Ship Alternative
The capsules would be disposed of offsite at a potential geologic repository in compliance with all regulatory requirements. This alternative would cost an estimated $607 million. The cesium and strontium capsules may not meet the current waste acceptance criteria of a potential geologic repository because the waste is in a corrosive form (cesium and strontium salts). Chemically processing the waste to a less corrosive form or placing the waste in containers that would not corrode for up to 500 years may be required to implement this alternative.

Vitrify with Tank Waste Alternative
This alternative would meet all regulatory requirements and the current requirements for accepting waste at a potential geologic repository. Implementing this alternative is dependent on selection of one of the tank waste alternatives that includes a high-level waste vitrification facility. All cesium and strontium would be disposed of offsite at a potential geologic repository as part of the vitrified high-level waste. This alternative would cost an estimated $641 million.

Basis for Not Identifying a Preferred Alternative
Because the encapsulated cesium and strontium capsules have potential commercial value as irradiation or heat sources and implementing disposal alternatives would foreclose options for commercial applications, DOE and Ecology do not have a preferred alternative at this time. Additionally, there are major differences in cost between continued wet storage and the other alternatives that were analyzed. Given these factors and the uncertainties they present, further evaluation including public input is needed before a preferred alternative can be determined.

S.8 PUBLIC INFORMATION AND INVOLVEMENT

The Tank Waste Remediation System EIS is available for review in DOE Public Reading Rooms and Information Repositories, as presented in Table S.8.1. For a copy of the EIS, call or write the DOE or Ecology official listed in the following section. The EIS is contained in five volumes and this summary, which include the text of the EIS (Volume One) and 10 appendices (Volumes Two through Five) (Figure S.8.1). The appendices contain the detailed technical materials and data prepared to support the analyses summarized in the text of the EIS.

Table S.8.1 DOE Reading Rooms and Information Repositories

Location	Address
Suzzallo Library	University of Washington Suzzallo Library Government Publications Room Mail Stop FM-25 Seattle, Washington 98195
Foley Center	Gonzaga University E. 502 Boone Spokane, Washington 99258
DOE Reading Room	Washington State University Tri-Cities Campus 100 Sprout Road, Room 130 Richland, Washington 99352
Bradford Price Millar Library	Portland State University Science and Engineering Floor SW Harrison and Park P.O. Box 1151 Portland, Oregon 97207
DOE Freedom of Information Reading Room	Forrestal Building 1000 Independence Avenue, SW Washington, D.C. 20585

S.8.1 DOE and Ecology Contacts

For further information on this EIS, call or write:

Carolyn C. Haass
DOE NEPA Document Manager
U.S. Department of Energy
P.O. Box 1249
Richland, Washington 99352
Voice 1-509-372-2731
Message 1-800-321-2008
Facsimile 1-509-736-7504

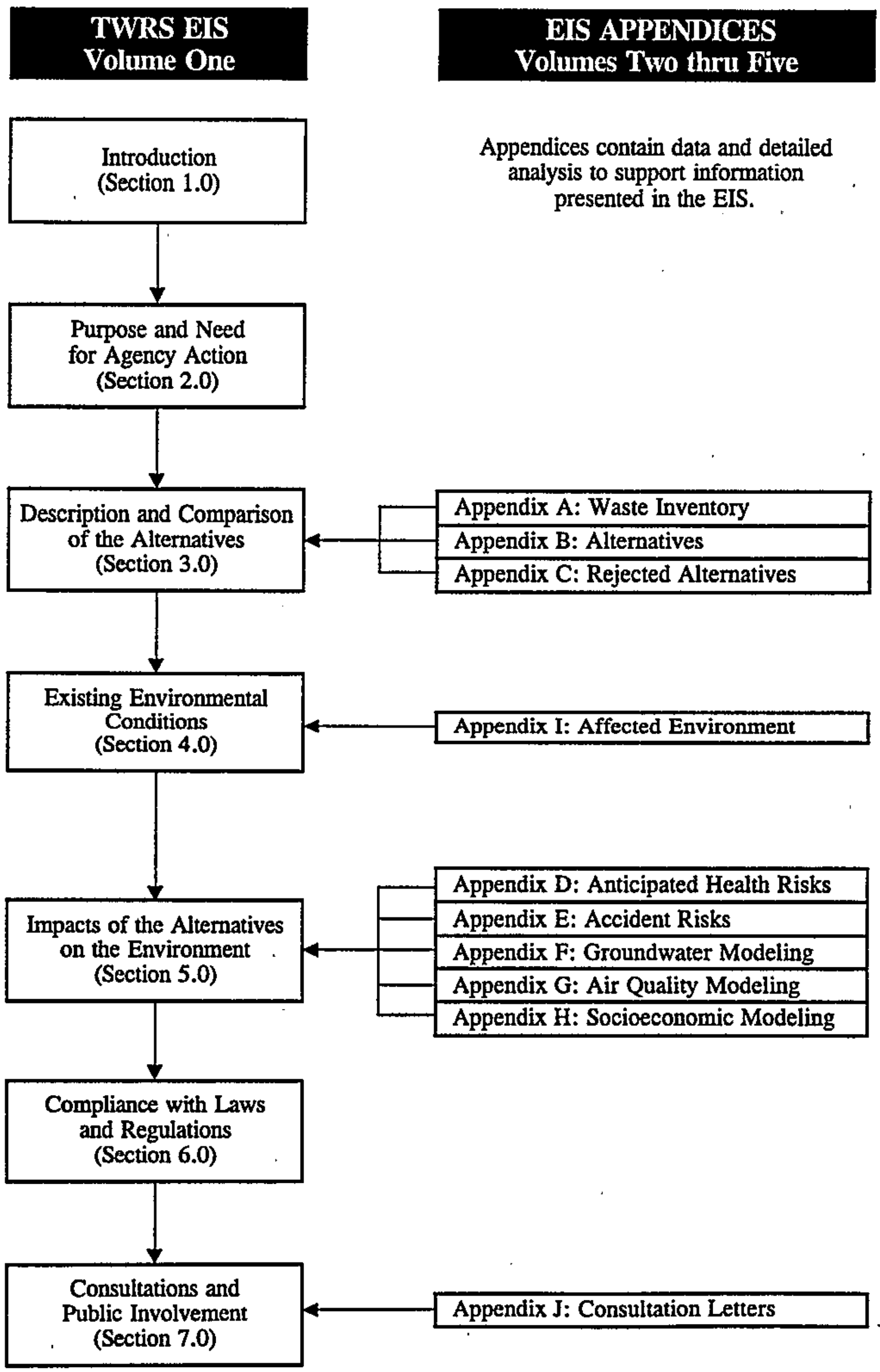
Geoff Tallent
Tank Waste Remediation System EIS Project Lead
Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600
Voice 1-360-407-7112
Message 1-800-321-2008
Facsimile 1-360-407-7151

S.8.2 Public Comment Period on the Draft EIS

DOE and Ecology invite interested parties to submit written comments concerning the Draft EIS during a 45-day comment period. Written comments on the Draft EIS will be accepted by the DOE and Ecology contacts listed in the preceding text through the last day of the comment period. Comments postmarked after that date will be considered to the extent practical.

The public also is invited to attend public hearings. At these hearings, oral and written comments will be received on the Draft EIS. The dates and locations of the public hearings will be announced in local newspapers. Oral and written comments will be considered equally in preparing the Final EIS.

Figure S.8.1 Guide to the Contents of the TWRS EIS



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